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FACILITIES PLANNING & CONSTRUCTION INTERNSHIP

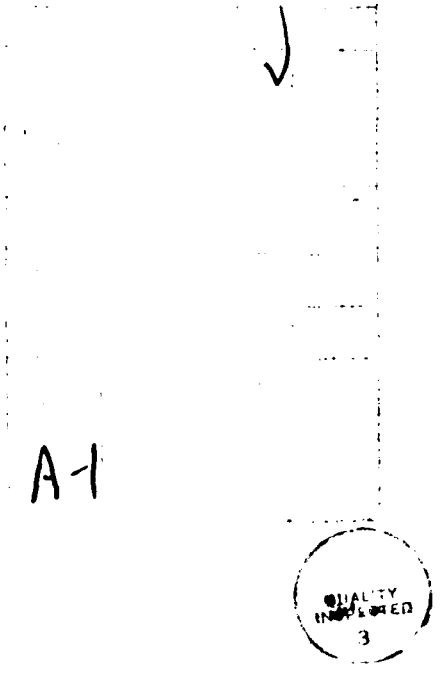
A Record of Study

by

MICHAEL FLOYD REYNOLDS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree
of

DOCTOR OF ENGINEERING



December 1990

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FACILITIES PLANNING & CONSTRUCTION INTERNSHIP

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December 1990

ABSTRACT

Facilities Planning & Construction Internship

December 1990

Michael Floyd Reynolds, B.S., US Air Force Academy;

M.S., Purdue University

Chair of Advisory Committee: Dr. George Stukhart

The Texas A&M University System Department of Facilities Planning & Construction is one of the largest university engineering organizations in the United States. It maintains engineering and construction capabilities to respond quickly and efficiently for the needs of the entire university system.

The Department of Facilities Planning & Construction with a staff of approximately 61 engineers, engineering technicians, clerical staff and construction representatives, is administering approximately 40 active construction contracts totalling in excess of $200 million. Construction placement in FY91 is expected to exceed $70 million.

The emphasis for this internship was on engineering and construction in the Texas A&M University System. Proper engineering and construction methods have become increasingly important and a necessary function in the quest for quality construction completed on time and

within budget. There are a host of reasons for this, most relating directly to the strict constraints placed on requirements, time and money. The cost of construction materials, labor, and equipment have soared and technology is rapidly changing the construction techniques and kinds of materials and equipment used. It is obvious that prudent engineering and construction methods are essential to attain successfully completed projects.

Effective administration, engineering, scheduling, quality control and quality assurance are primary ingredients to effective engineering methods. Each is of practical concern to the organization and the intern. The purpose of this report is to document the experiences acquired during the internship and demonstrate that the objectives of the internship have been met.

ACKNOWLEDGEMENT

Special thanks is extended to the men and women of the Facilities Planning and Construction Department for their support of the internship program. They were supportive of the internship and treated me with the upmost respect and courtesy. There were numerous instances when they went out of the way to explain various construction problems and issues that are not covered in most classrooms or textbooks.

Sincere thanks is given to my wife, Debbie, for her continual support, understanding, patience and love. Even in times of Debbie's serious illness, she was always supportive. There were times when I felt it was her strength that carried me through difficult times.

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INTERNSHIP INTRODUCTION AND OBJECTIVES

The internship objectives are divided into two categories, specific objectives and general objectives.

The major emphasis of the internship was to satisfy the specific objectives outlined below. The specific objectives were independent tasks the organization wanted examined and researched. The tasks required inquiry at various elements of the organization and application of tools from academic work while at Texas A&M. These objectives required more than simple day to day work in the organization. They required research, study, probing, investigation and computer analysis. Each specific objective is covered in detail in this Doctor of Engineering Report of Study. The specific objectives are:

1) Accomplish a detailed inquiry into the organizations' cost forecasting method in order to forecast monthly construction obligations. The organization is required to furnish the budget office with a forecasted budget of expenditures two months in advance. This task involved analyzing previous contractor payments in order to develop a monthly cash flow model to predict future cost outlays.

2) Research and make recommendations for the

Journal model is Journal of Construction Engineering and Management.

effectiveness of hiring a Construction Manager (CM) or establishing a CM in house.

3) Establish a job accounting system in the construction division that tracks actual inspection costs for each contract.

4) Analyze the benefits of the TAMU System providing site utilities for the contractors versus requiring contractors to pay for their own utilities. Currently the contractors are required to pay for any temporary utilities included in their contract.

The remaining objectives are extremely general in nature and were achieved through daily interaction on construction projects during the internship. The following objectives are not discussed in detail; however, they are covered in the discussion of several construction projects. The general objectives are:

1) Learn the organization's leadership and management style and preferred methods for goal setting, time management, motivating subordinates, effective communication, information management, dealing with superiors, and stress management. To do this required remaining cognizant of these items while working during the tenure of the internship.

2) Learn how the Texas A&M system budget cycle and approval process work, how the funds flow down to the

various operating levels, and how they assess future workloads and manpower requirements.

3) Learn about the ethical issues encountered by contractor and facilities personnel. This requires daily observation and experience, and open discussions on the topic with key personnel on both sides.

4) Perform a study and evaluation of the use of computers within the organization and recommend any improvements while learning first hand the advantage of using a computer in the engineering field.

5) Assure that the technical requirements of the contracts are met. This requires close coordination with the contractors, fellow inspectors and engineering support personnel.

6) Be responsive to requests by contractors and users to make changes or modifications to the projects. This requires determining acceptability of the request after a thorough review, followed by prompt negotiations on the issues involved.

7) Give positive direction to the project. This requires planning ahead and anticipating problem areas.

8) Maintain close monitoring and communications with contractors to assure accurate accounting of progress, costs, and quality of work.

9) Promote project safety.

10) Assure that project costs are determinable at any given time. This requires utilizing cost accounting and control procedures for the project.

11) Assist in the preparation for weekly and monthly meetings planned for various parties of the university system.

12) Assist in the long range planning of facilities in the Texas A&M University System.

13) Assist in the A/E selection process.

The specific and general objectives above are discussed in the report following the chapters on the organizational structure.

TEXAS A&M UNIVERSITY SYSTEM ORGANIZATION

The construction program for the Texas A&M University System is administered by the Facilities Planning and Construction Department (FP&C), one of the largest university engineering organizations in the United States. It maintains engineering and construction capabilities to respond quickly and efficiently for the entire university system. FP&C, with a staff of approximately 61 engineers, engineering technicians, construction representatives and clerical staff, is presently administering approximately 40 active construction contracts totalling in excess of $200 million. Although FP&C is a department at Texas A&M, it is totally self supporting. Fees associated with planning and construction provide the organization with the necessary funds of operation.

FP&C is comprised of three divisions, Planning, Construction and Administration with each division reporting to the Vice Chancellor for Facilities Planning and Construction. The Vice Chancellor in turn, reports to the Deputy Chancellor for Finance and Administration and provides staff support for the System Chief Executive Officers and the Board of Regents' Planning and Building Committee. The Figure 1 on the following page graphically displays the system's construction organizational chart.

Construction placement in FY91 is expected to exceed

$70 million. Proper engineering and construction methods have become an increasingly important and necessary function in the quest for quality construction completed

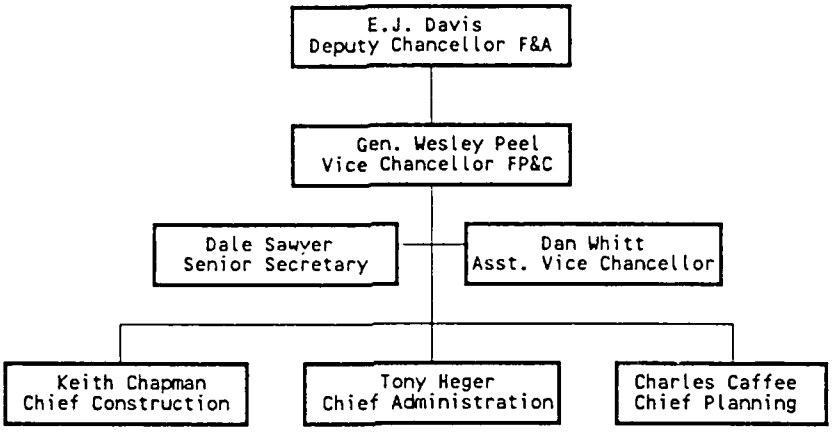


FIG. 1. System Construction Organizational Chart

on time and under budget. There are a host of reasons for this, most relating directly to the strict constraints placed on time and money. The cost of construction materials, labor, and equipment have soared and technology is rapidly changing the construction techniques and kinds of materials and equipment used. Effective engineering, administration, scheduling, quality control and quality assurance are primary ingredients of effective engineering methods. Since the emphasis for the internship was on construction, the majority of the internship was spent working in the Facilities Construction Division.

FACILITIES CONSTRUCTION DIVISION

The Facilities Construction Division is one of three divisions in the Department of Facilities Planning and Construction that is charged with representing the Board of Regents as the Owner of construction projects for the Texas A&M University System. Specifically, the Construction Division acts as the Owner's representative during the construction phase of projects. A staff of twenty-three full-time and part-time employees manages an annual volume of $40 million to $60 million of construction placement. The value of individual projects ranges from less than $100,000 to over $20 million.

Besides the main office on the Texas A&M campus, three satellite offices are currently in operation:

- One inspector and one part-time clerk at Prairie View A&M University administer six active projects valued at $8.1 million.
- One inspector administers two projects at Tarleton State University valued at $3.6 million, and one project in Dallas valued at $2.5 million.
- One project manager and two inspectors administer one project in Houston valued at $21.5 million, and three in Galveston valued at $5.1 million.

In addition to work at the above three campuses, the Construction Division administers construction projects as needed for the following agencies:

- Texas Agricultural Experiment Station
- Texas Forest Service
- Texas Engineering Experiment Station
- Texas Engineering Extension Service

The Construction Division provides on-site inspection, materials testing and administration of the construction contracts for a fee of 1.9 percent of the construction value. The fee is paid by the using agency for each project from funds appropriated for the project. The fee pays all operating expenses of the construction division. Therefore, the duties and number of employees are influenced by the dollar volume of actual construction. This is one reason why a forecasting model was required in order to staff the organization.

Personnel

The Construction Division is comprised of 24 employees including the intern. See Figure 2 on the following page for a graphical illustration of the Construction Division organizational chart. Due to the function of the organization, the various duties among employees vary significantly. A key to satisfying several internship objectives depends on understanding the duties of the employees below.

Manager, Construction Division

- Supervises and manages, through the Construction Division staff, the inspection, contract administration and funding management of all construction projects for the system.
- Member of the A/E pre-selection committee and the review team for the Planning and Building Committee

of the Board of Regents.
- Serves as Project Manager of selected projects.
- Approves contract changes valued less than $10,000.

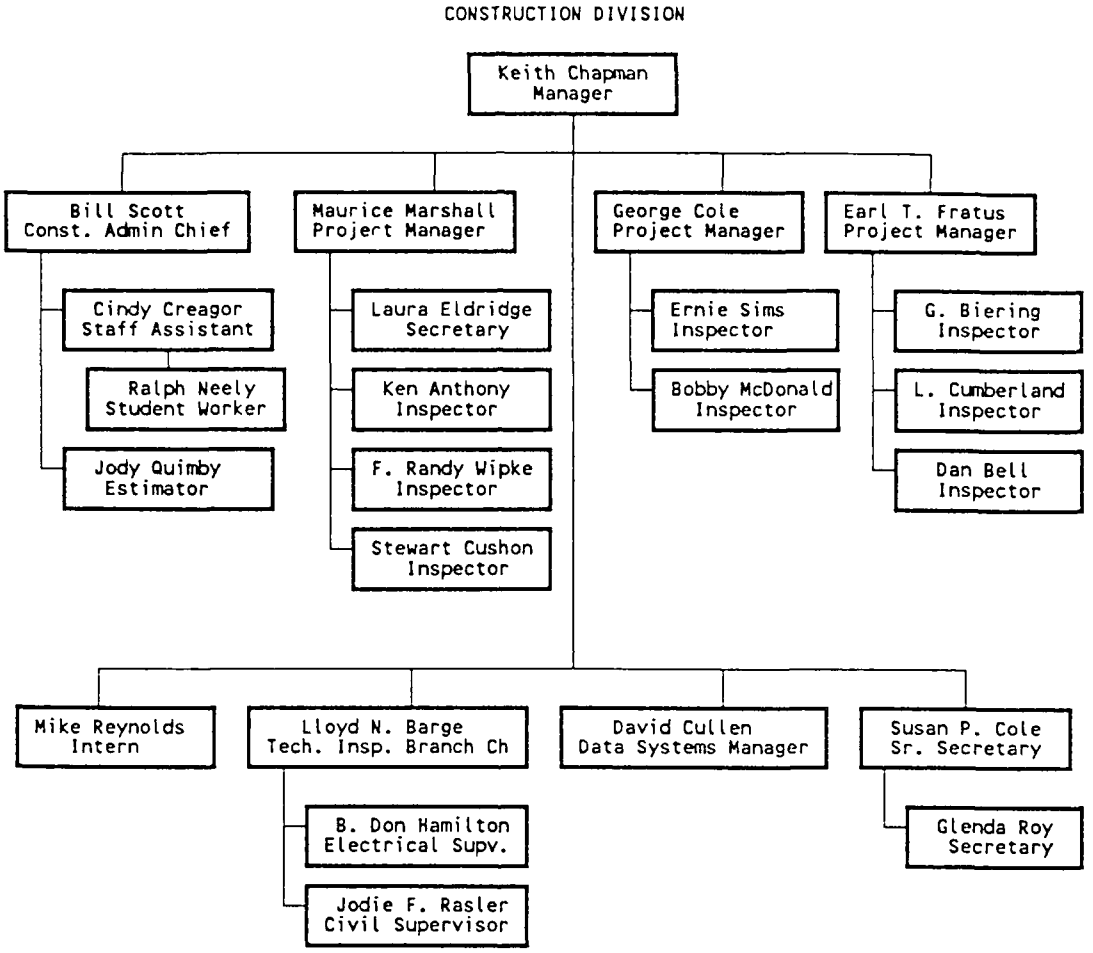


FIG. 2. Construction Division Organizational Chart

Chief, Contract Administration Branch

- Administers contract changes.
- Prepares independent cost estimates for contract changes.
- Negotiates time and cost of contract changes for changes exceeding the Project Managers' approval authority.
- Prepares briefing papers and negotiates for all claims.

- Maintains the current status of funds available for contract changes.
- Develops and maintains management information system, including computer hardware and software.
- Develops statistical analysis of construction placement data.
- Maintains contract submittals and documents.
- Maintains monthly construction status report.
- Manages division's training program.
- Serves as Project Manager on selected projects.
- Maintains technical library and publications file.

Project Manager

- Supervises up to six inspectors in the administration and technical supervision of up to fifteen projects.
- Acts as Owner's representative for individual contracts.
- Reviews bidding documents for constructability and conformance with the Owner's standards.
- Attends detailed design reviews at 90 percent and 100 percent completion of design.
- Conducts pre- construction conferences attended by the contractor, subcontractors, A/E, using agency and Project Inspector.
- Conducts or attends regularly scheduled progress meetings.
- Initiates contract changes.
- Approves contract changes valued less than $3,000.00.
- Coordinates construction schedules with campus agencies.
- Conducts final inspections and close out of construction projects including distribution of O&M manuals, warranties and "as-built" drawings.

Project Inspector

- Reviews bidding documents for constructability and conformance with the Owner's standards.
- Attends reviews of detailed design at 90 percent and 100 percent completion of design.
- Inspects all material, equipment and construction activities for compliance with contract requirements.
- Maintains daily journal of project activities.
- Verifies resources expended by contractor on force account (time and material) contract changes.

- Coordinates materials testing by Owner's testing agencies.
- Maintains and reviews approved submittals.
- Recommends the amount of monthly payment due the contractor.
- Attends monthly progress meetings.
- Coordinates above-ceiling, pre-final and final inspections.
- Recommends time extensions due to weather delays.

Mechanical Supervisor

- Assists Project Managers and Inspectors by seeing that all mechanical work meets contract requirements.
- Assists Project Managers and Inspectors with interpretation of contract documents and codes regarding mechanical work.
- Reviews bidding documents for conformance with the Owner's mechanical systems standards and codes.
- Attends reviews of detailed design at 90 percent and 100 percent completion of design.
- Conducts above-ceiling inspections for mechanical work.
- Hires testing and balancing consultants for final testing, balancing and certification of HVAC systems.

Electrical Supervisor

- Assists Project Managers and Inspectors by seeing that all electrical work meets contract requirements.
- Assists Project Managers and Inspectors with interpretation of contract documents and codes regarding electrical work.
- Reviews bidding documents for conformance with the Owner's electrical systems standards and codes.
- Attends reviews of detailed design at 90 percent and 100 percent completion of design.
- Conducts above-ceiling inspections for electrical work.
- Hires consultants for testing electrical systems.

Civil Supervisor

- Assists Project Managers and Inspectors by seeing that all civil work meets contract requirements.

- Assists Project Managers and Inspectors with interpretation of contract documents and codes regarding civil work.
- Reviews bidding documents for conformance with the Owner's civil systems standards and codes.
- Attends reviews of detailed design at 90 percent and 100 percent completion of design.
- Hires materials testing laboratories for earthwork, foundation and concrete testing.
- Serves as Project Inspector on selected projects.

Data Systems Manager

- Writes computer programs for use as management tools.
- Modifies existing software packages (those developed in house and purchased)
- Serves as system administrator on microcomputer LAN system.
- Assist office personnel on the use of microcomputers.
- Assist Project Managers in the implementation of computers in to the division operations.
- Purchases and Repairs office computers and associated equipment.
- Maintains inventory of computer hardware and software.
- Knowledge of Autocad and Primavera.

Construction Estimator

- Assists office personnel in evaluation of contract change proposals and claims by preparing detailed labor and material estimates.
- Collects cost and pricing data for use in preparation of estimates.
- Develops and periodically updates construction cost database for information management system.
- Assists with the negotiation of time and cost of construction changes.

Based on the duties above, intern duties were composed of a cross section of duties from various positions above. In order to gain a greater insight into

the function of the organization, the duties were as follows:

Intern

- Temporary Member of the A/E pre-selection committee
- Serves as Project Manager of selected projects.
- Prepares independent cost estimates for contract changes.
- Assists in developing and maintaining the management information system, including computer hardware and software.
- Develops statistical analysis of construction placement data.
- Supervises inspectors in the administration and technical supervision of projects.
- Acts as Owner's representative for individual contracts.
- Reviews bidding documents for constructability and conformance with the Owner's standards.
- Attends detailed design reviews at 90 percent and 100 percent completion of design.
- Conducts pre-construction conferences attended by the contractor, subcontractors, A/E, using agency and Project Inspector.
- Conducts or attends regularly scheduled progress meetings.
- Initiates contract changes.
- Approves contract changes valued less than $3,000.00.
- Coordinates construction schedules with campus agencies.
- Assumes the duties of Inspectors in their absence due to vacation or sickness.
- Coordinates materials testing by Owner's testing agencies.
- Recommends time extensions due to weather delays.
- Assists other Project Managers and Inspectors by seeing that civil work meets contract requirements.
- Assists Project Managers and Inspectors with interpretation of contract documents and codes regarding civil work.
- Writes computer programs for use as management tools.

Throughout the yearly internship, the above duties were challenging and enhancing. The yearly internship

satisfactorily emphasized engineering practice, public service and the development of leadership potential while placed in a position of responsibility and authority.

FORECASTING MODEL

Objective - Develop A Monthly Cash Flow Model

The objective of this assignment task was to accomplish a detailed inquiry into FP&C's cost forecasting method in order to improve the monthly forecasted construction obligations. Presently, the obligations are calculated manually. This task would involve writing a computer program in order to automate the forecasting method.

Task Description

The FP&C Department is required to furnish the University Budget Office with a new forecast of expenditures two months in advance. This particular cost forecasting is required by the fiscal office so that the University may cash in bonds or treasury stock to generate the funds to pay for the present construction. This task involves analyzing previous contractor payments in order to develop a monthly cash flow computerized model to predict future cost outlays. In addition to the above requirement, the computer forecasting model would serve other purposes in the organization. The model could be used as the basis for the Construction Division's yearly budget estimates and manpower requirements. Since the Construction Division is totally self-supportive and the

construction volume changes year to year, a forecasting model is required to properly staff the organization and provide a positive cash budget.

Administration And Managerial Assignments

The only managerial assignment in this particular task involves working with various members of the organization to determine what database files are available or need to be generated to gather the information required to develop the cost forecasting model. Throughout this task, the work was directed by the internship supervisor, Mr. Chapman. Mr. Chapman reviewed various stages of this task to ensure the development of a model in a form that would be useable when completed. David Cullen, who developed an earlier model using a different approach, was consulted at various times in the model development. We attempted to compare the model with the two that had been done in the past. Once the model was completed, I trained various members of the organization who would use or generate the report.

The major administrative assignment was to document the work that was done in order to ease future rework by others once I left the organization. Proper documentation is invaluable when other programmers are modifying the code or reports. Adding or making minor changes to

computer programs without the proper documentation is lengthy, frustrating and often leads to further errors.

Description Of Non-technical Problems

Due to the large amount of financial transactions that go on at the campus, not only for construction but also such things as salaries and other expenses of the University, budget forecasting is critical. In addition to the fiscal office requirement, the fundability of large projects that span several years can better be determined by the knowledge of precise financing requirements. Smaller projects could benefit by enabling the procurement of interim financing at reduced rates to meet progress payments as the job proceeds. In addition to determining financing requirements, the Owner, the Construction Division in this case, can use a cost forecasting method to determine what percent should be done at an approximate point in time. In other words, if the forecasting model determines that the contractor at this point in time should be approximately 50% done, construction division personnel can use that figure (50%) and look at the actual construction progress and make the determination whether or not it actually is 50% complete. If construction division personnel make the determination that the Contractor is only at approximately 30% complete, the

Construction Division may elect to withhold some or all of his pay request. It would also signal the fact that the Contractor is behind schedule and additional managerial decisions may be required.

The Method Or Approach To The Task

The first step in preparing a computerized model was to accomplish an inquiry into the organization's previous cost forecasting methods that they have used in the past. There were two previous methods that the organization had used to determine future cost. The first method used a pencil, calculator, and large sheet of paper--a very manual task. This method requires a great deal of time and did not use a computer at all. The method accomplished by the manager of the Construction Division required at least a day, and longer if additional changes were required or new information on actual construction amounts were obtained through bid openings. Needless to say, the first method was not done very often or with much accuracy. The second method generated a model with several data base files and a spreadsheet file to determine project cash flow. Although a tremendous improvement over the first method, it requires extensive spreadsheet manipulation which only one individual knew how to do and requires input from various other data base

files and users. Needless to say, if one of the individuals were sick or on vacation, the model could not be accomplished. The second method was definitely an improvement over the first; however, it still required several hours of time from various members of the organization.

At the time the second method model was developed, spreadsheets had to be used in order to statistically manipulate data since the database programs did not have, or were limited, in that capability. In order to improve on this method, it was necessary to incorporate a database with the spreadsheet. The current method that took several hours or in some cases even a day or more, would be shorten to less than seven or eight minutes. After analyzing the previous methods and determining the capabilities of an existing software hardware, I was able to develop a general outline of a computer program that could be written and yet use all the current data information. Therefore, no additional information had to be entered before generating a cost forecasting report. Writing the software was an easy issue, but it would take a lot of time to write the code. The major problem in developing the model was to generate the cash flows for all the various project types.

Sources Of Information Required To Perform Task

There were several sources of information required to perform the task. The first source was the library to see if anyone else had ever published this kind of work before. There have been several articles published in the last couple of years that talked about the advantages and disadvantages of cost forecasting. Each one discussed the development of models--the major consensus being that the model has to be developed from historical data within the organization (Patten 1987). The second source of information was the software manuals. Since the software program will be required to implement this particular task, I had to do considerable research into a new software package that the organization just purchased. This new package, a database program that could be operated in a Local Area Network (LAN) type environment, was needed in order to exchange the numerous database files. Besides software, another source of information was the computer operator manuals themselves. Since I was not dealing with a stand alone computer, but a LAN system that tied all the computers in the organization together, data manipulation over the LAN system required additional research. Another source of information was my discussion with various professors such as Dr. Anderson, Dr. Kannan, Dr. Hancher, Dr. Stukhart. The major source of

information for this particular task was in reviewing the previous two generations of the organization's cost forecasting methods used in the past.

Discussion Of Pertinent Information

Most of the information for this particular task was available, but had to be researched. However, the entire task revolved around the generation of cost forecasting equations. After research of the various articles and magazines, and discussions with professors, it became commonly understood that project costs follow an "S" curve. However, the "S" curve is dependent on various factors such as the project duration, project cost, and even the type of construction. The major hurdle in accomplishing the entire task was to run a statistical analysis of the historical data in order to determine the equation or equations to be used in order to generate future cost projections. During the first statistical analysis, I developed a single equation for all 885 data points; however, when reviewing several graphical plots of the data, it was obvious that a single equation would not provide the best mathematical model. Previous work, by David Cullen - Data Systems Manager for the Construction Division, on the second generation model revealed three distinct data cost ranges: less than 3 million, between 3

and 7 million and greater than 7 million. In order to compare this model with the second model, I used the same ranges for the data points. A breakdown of the data points is found in the table below.

TABLE 1. Summary of Data Points

	Projects < $3M	Projects $3 - $7M	Projects > $7M
Number Of Projects	40	18	10
Number of Data Pts	420	280	185
Max Costs	2,792,231	6,252,458	16,473,370
Min Costs	82,634	3,106,749	7,733,477
Avg Costs	1,132,493	4,478,387	10,834,798
Max No. of Payments	18	21	23
Min No. of Payments	4	10	12
Avg No. of Payments	10.50	15.5	18.5

From existing database files, I was able to gather the 885 data points (see Appendix I, II and III) and run the statistical analysis. Once the mathematical model was derived, the forecasting program would use that particular equation in order to generate the reports with projected

costs. Graphical displays of Table 1 are illustrated in Figures 3, 4 and 5. Figure 3 graphically shows the range of the 40 projects which are less than three million dollars. Figure 4, includes the eighteen projects whose cost was between three and seven million dollars. The remaining ten projects, which are all over seven million dollars, are displayed in Figure 5.

As revealed in the figures, the project costs span the entire range from a low of $82,634 to a high of $16,473,370 with a fairly consistent distribution of projects in between. Although there were only 68 projects there were 885 data points in which to run the statistical analysis. Figures 6, 7 and 8, plot the data points and their associated equation. The data points are listed in Appendix I, II and III. There have been several articles written on modeling the cash flow. For example, the article written by Patten compares a model he developed with a polynomial expression developed by Peer. Both modeling equations were accurate; therefore, I selected a polynomial equation since I had the software needed to generate that type of equation.

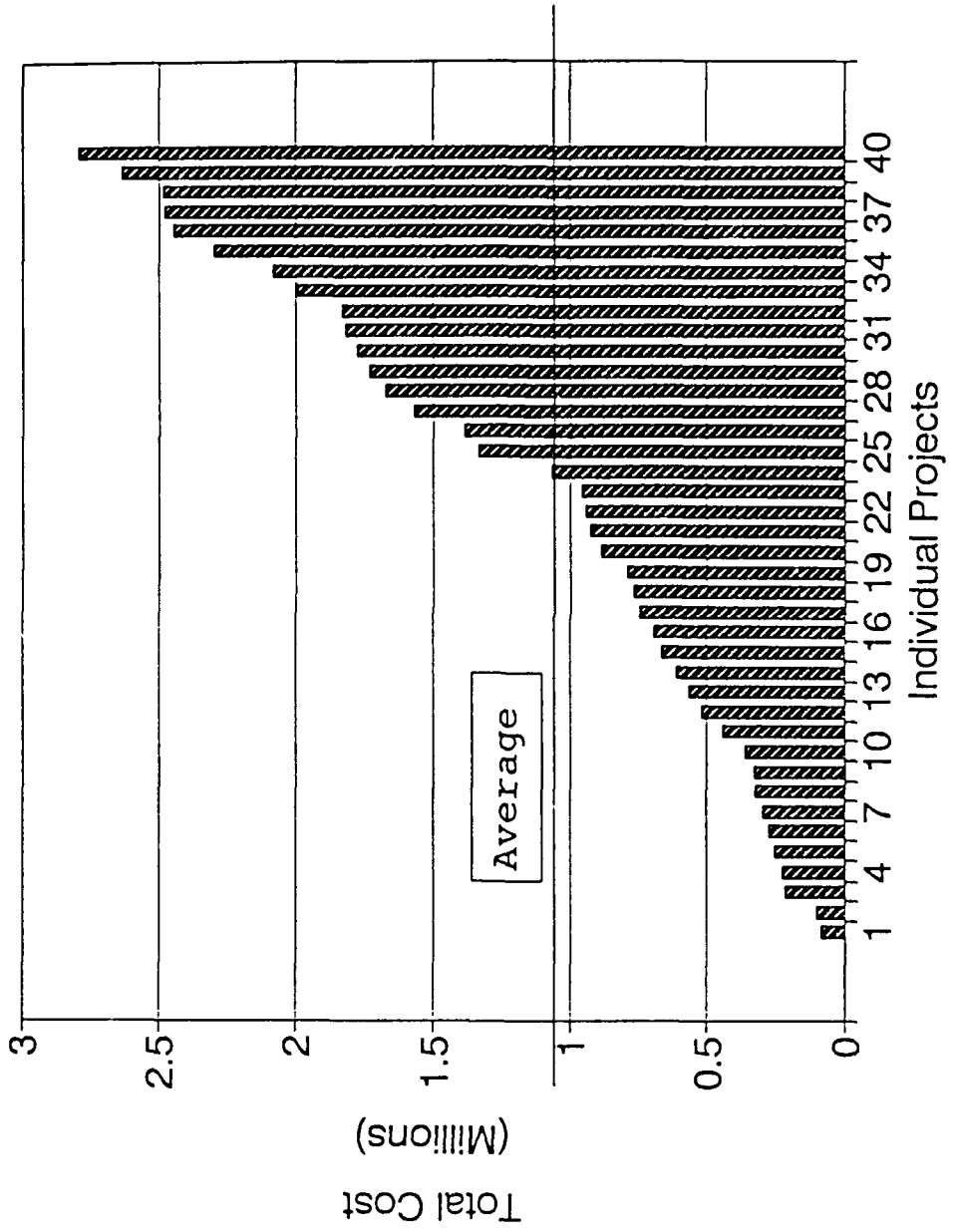


FIG. 3. Projects Less Than $3 Million

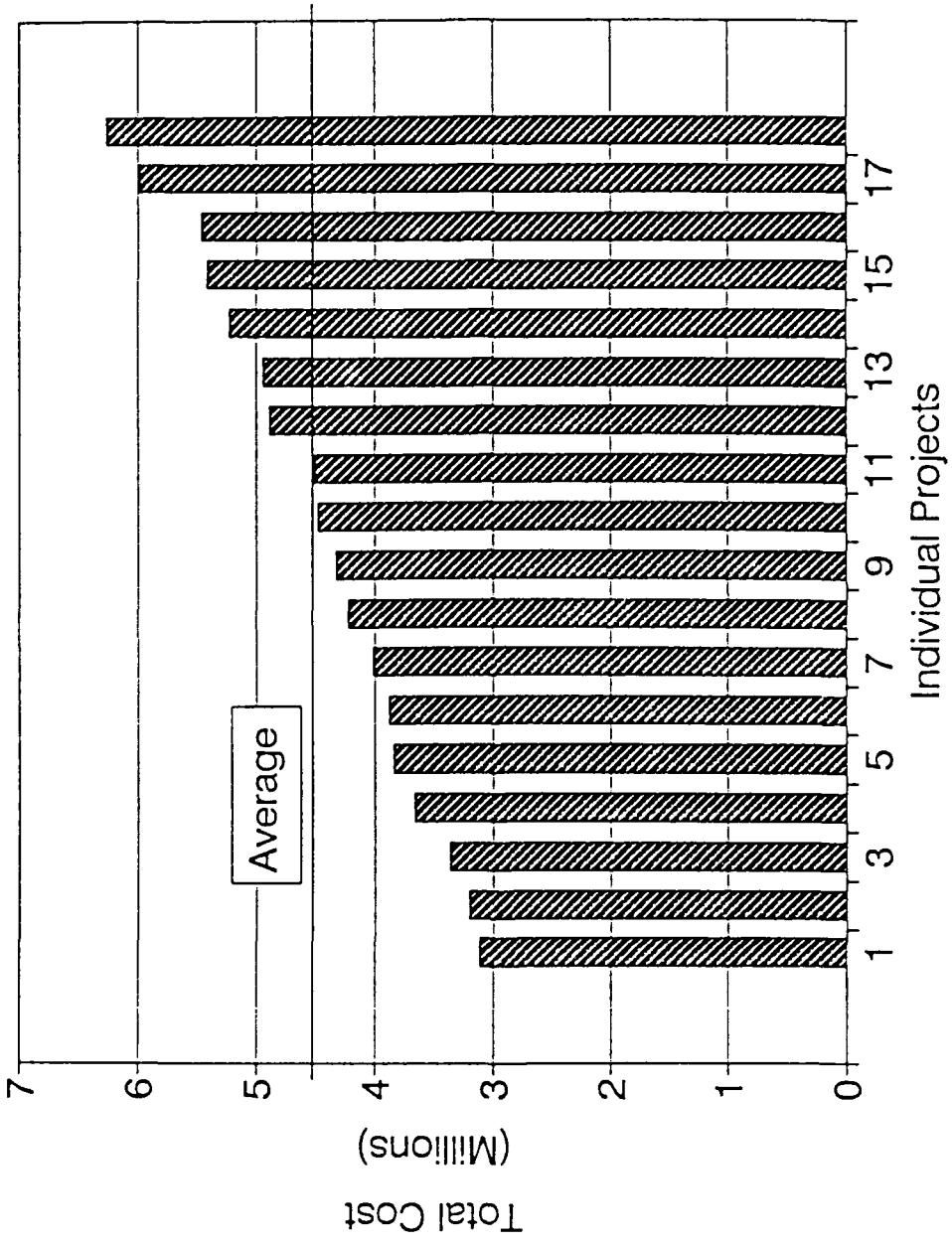


FIG. 4. Projects Between $3 & $7 Million

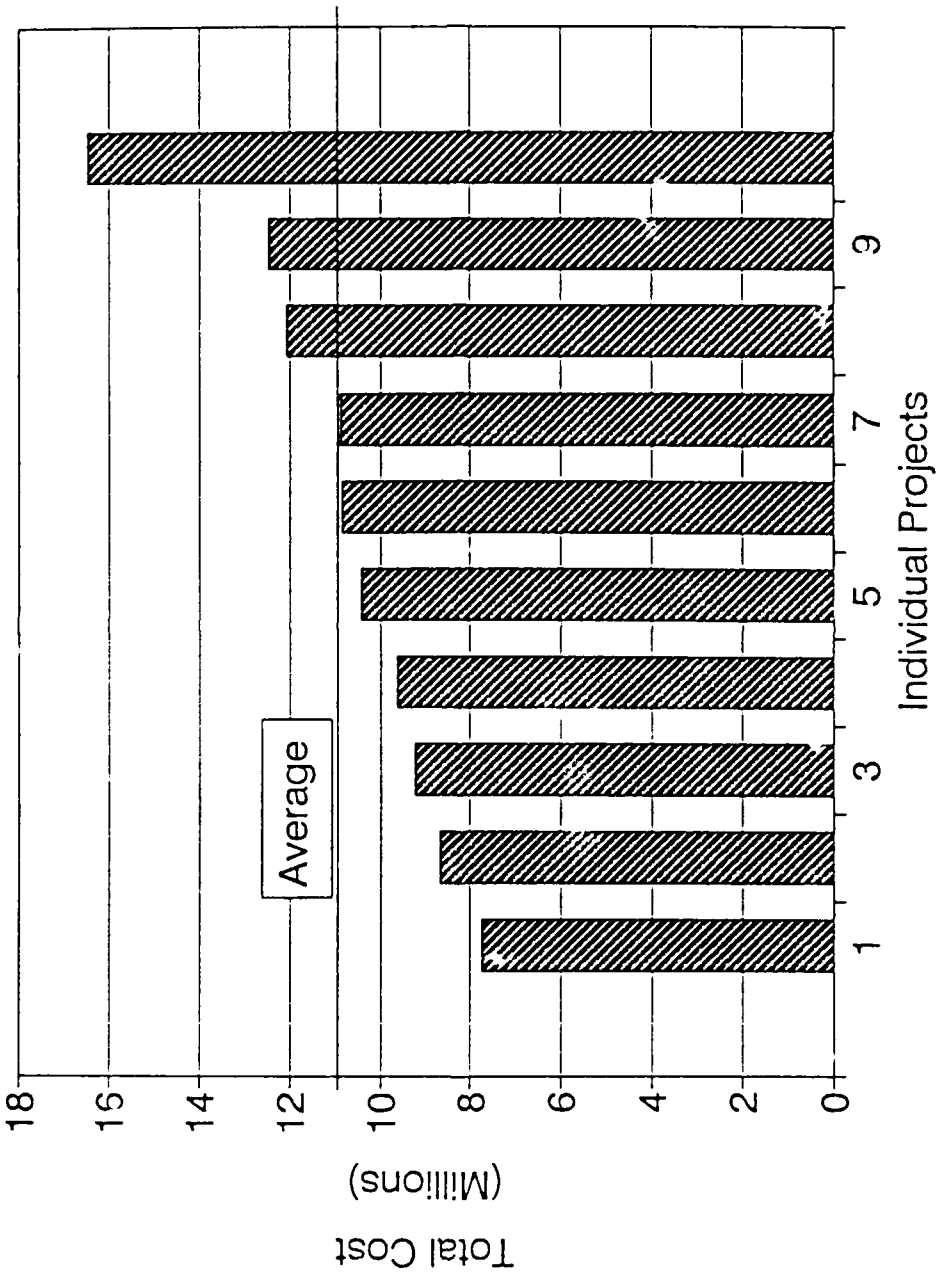


FIG. 5. Projects Over $7 Million

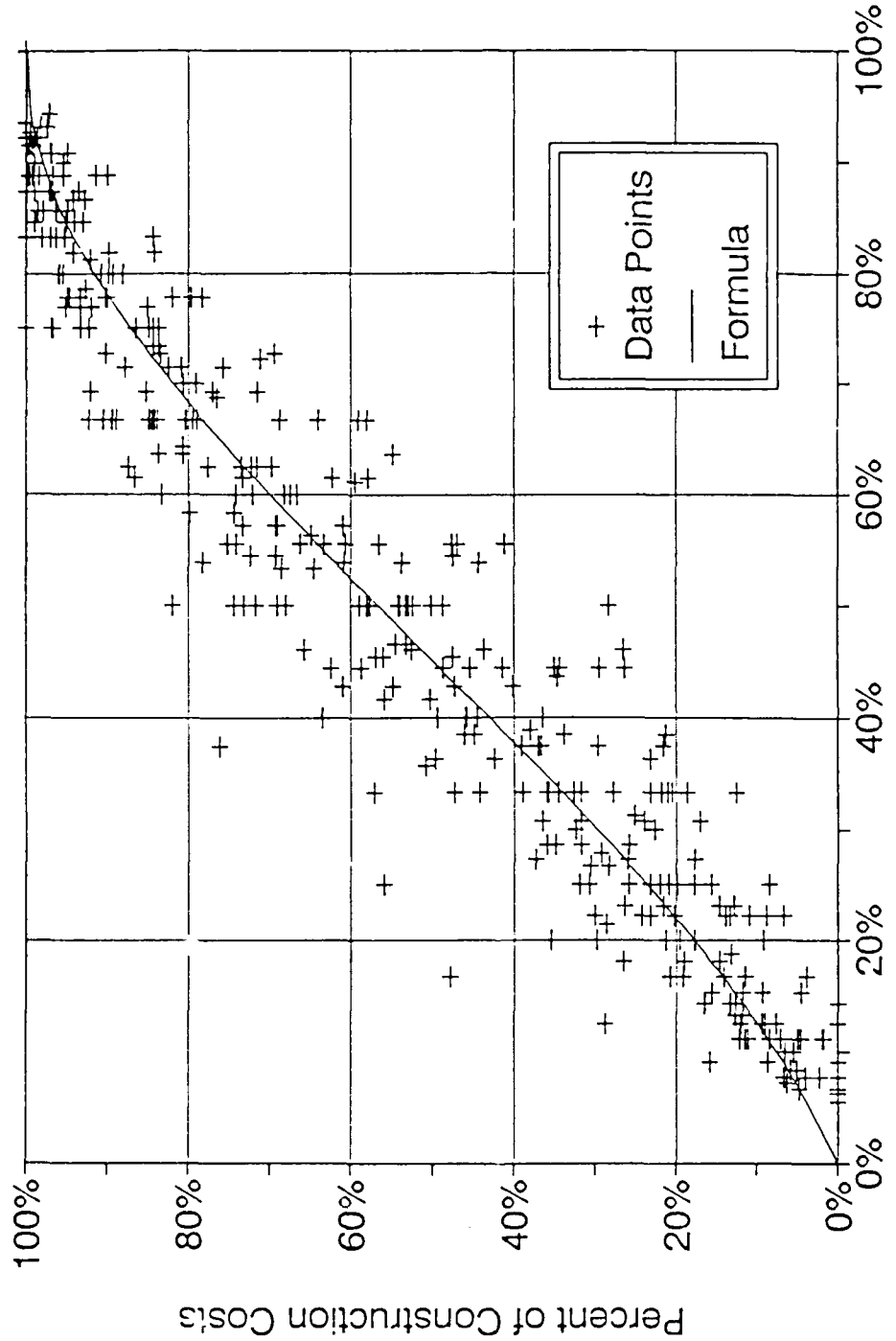


FIG. 6. Data Points for Projects <$3 Million

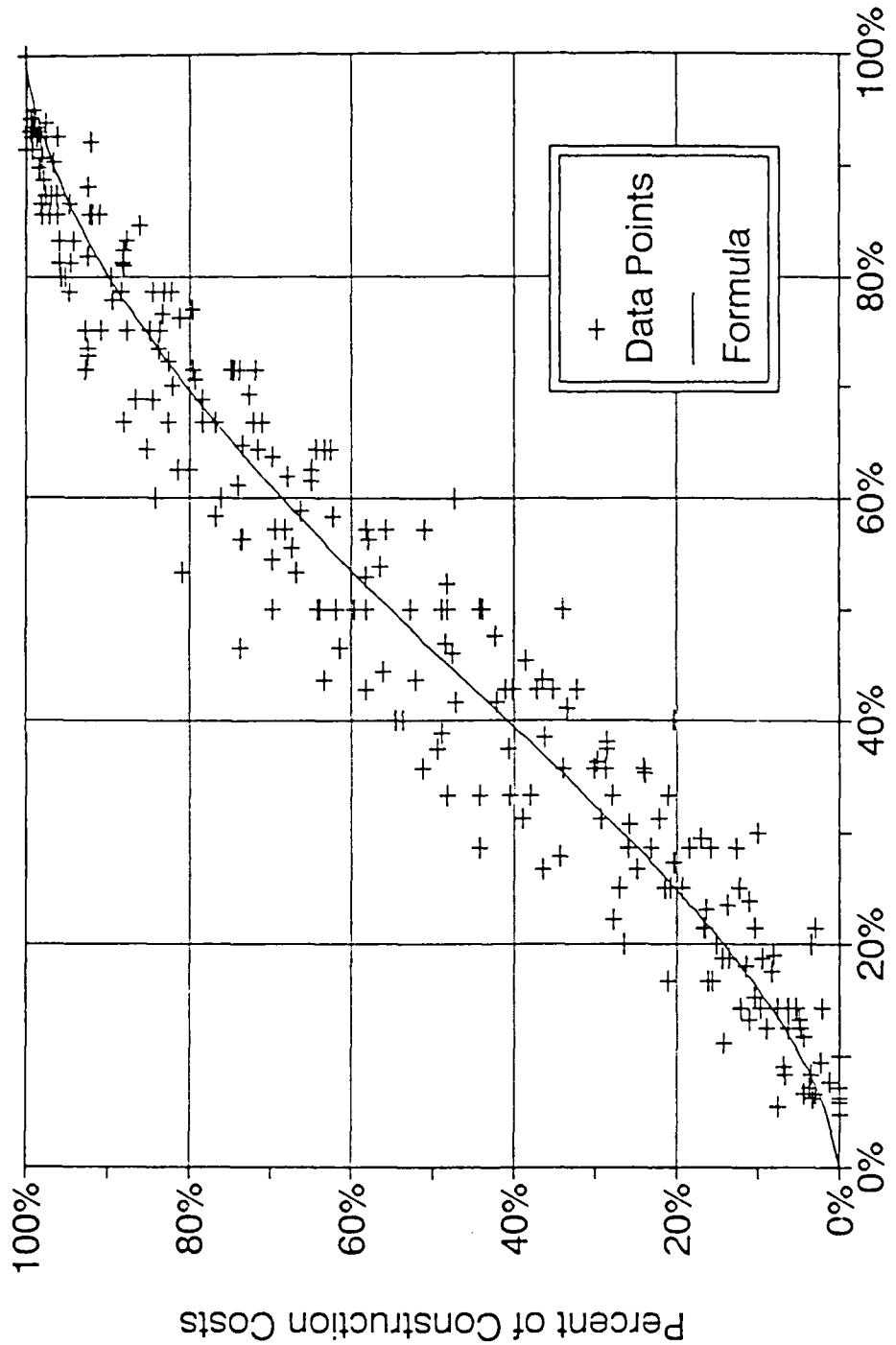


FIG. 7. Data Points for Projects $3 - $7 Million

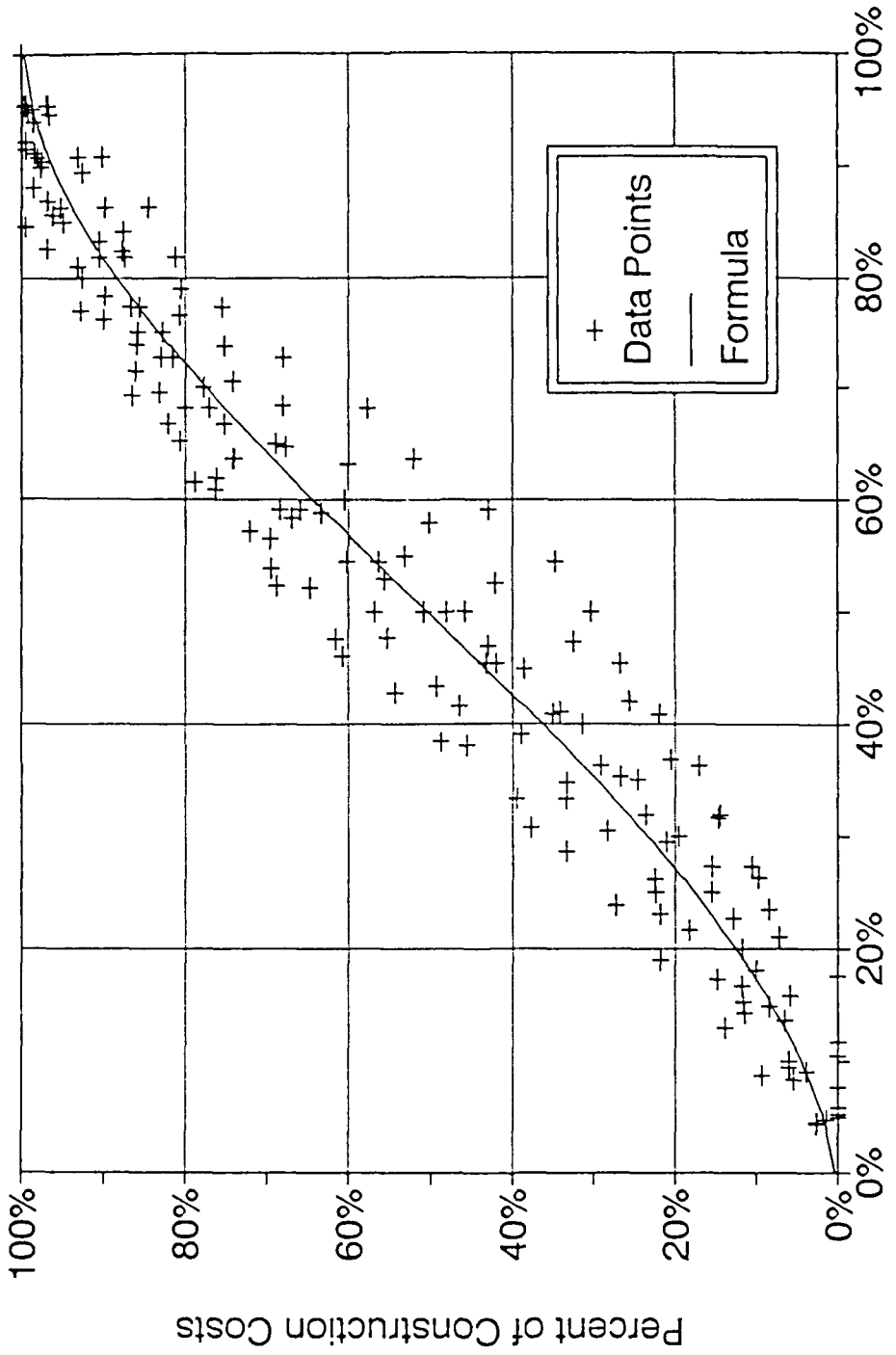


FIG. 8. Data Points for Projects >$7 Million

From the data, several runs of equations were developed and plotted. A single order equation, straight line, was not selected since historical data and research dictates an "S" shape curve. A second order, or quadratic curve, was more accurate; however, it was not accurate in the range of 20-80% of the construction time period. Therefore, I looked at third and fourth order equations and after several plots, I selected the fourth order equations. The equations were generated from a public domain statistical software program, "XY", written by Jack Klein. The program calculated the equations using the method of least squares. The fourth order equations are as follows:

ALL PROJECTS

$$Y = -0.00140+(0.40360*X)+(2.21740*X^2)-(1.69994*X^3)+(0.07879*X^4) \quad (1)$$

where Y = Percent of Construction Cost
X = Percent of Time

PROJECTS <$3 MILLION

$$Y = -0.00152+(0.61578*X)+(1.56162*X^2)-(0.90625*X^3)-(0.27169*X^4) \quad (2)$$

PROJECTS $3 - $7 MILLION

$$Y = -0.00063+(0.16453*X)+(3.36899*X^2)-(3.44100*X^3)+(0.91039*X^4) \quad (3)$$

PROJECTS >$7 MILLION

$$Y = 0.00240+(0.19008*X)+(2.36807*X^2)-(1.42462*X^3)-(0.14005*X^4) \quad (4)$$

Figure 9 graphically depicts the four equations. From the review of Figure 9, it can be seen that a single "S" shape curve(All Projects) cannot be used to forecast the entire spectrum. There is simply too much difference in the earned values between the four equations.

A single equation when graphically shown cannot be used to represent the entire spectrum of construction projects due to the percent differences between the curves. Figure 10 shows the percent difference between using a single equation (Equation 1) compared to Equations 2, 3 and 4. On smaller dollar projects the difference is not significant, but on a ten million dollar project, 4.5% difference represents a variation of $450,000 between a forecasted cash flow for a given time period. Thus, if a single equation is used, projects over seven million dollars would have an over-inflated cost projection and projects less than three million dollars would be under-inflated. See Figure 10 for the difference in earned values for the various time periods between the three curves and a single equation curve. In conclusion, the forecasting model database program applies the equation which corresponds to the actual or projected contract amount. For example, if the contract was for ten million dollars, equation 3 would be used in order to calculate the forecasted amounts based on contract duration.

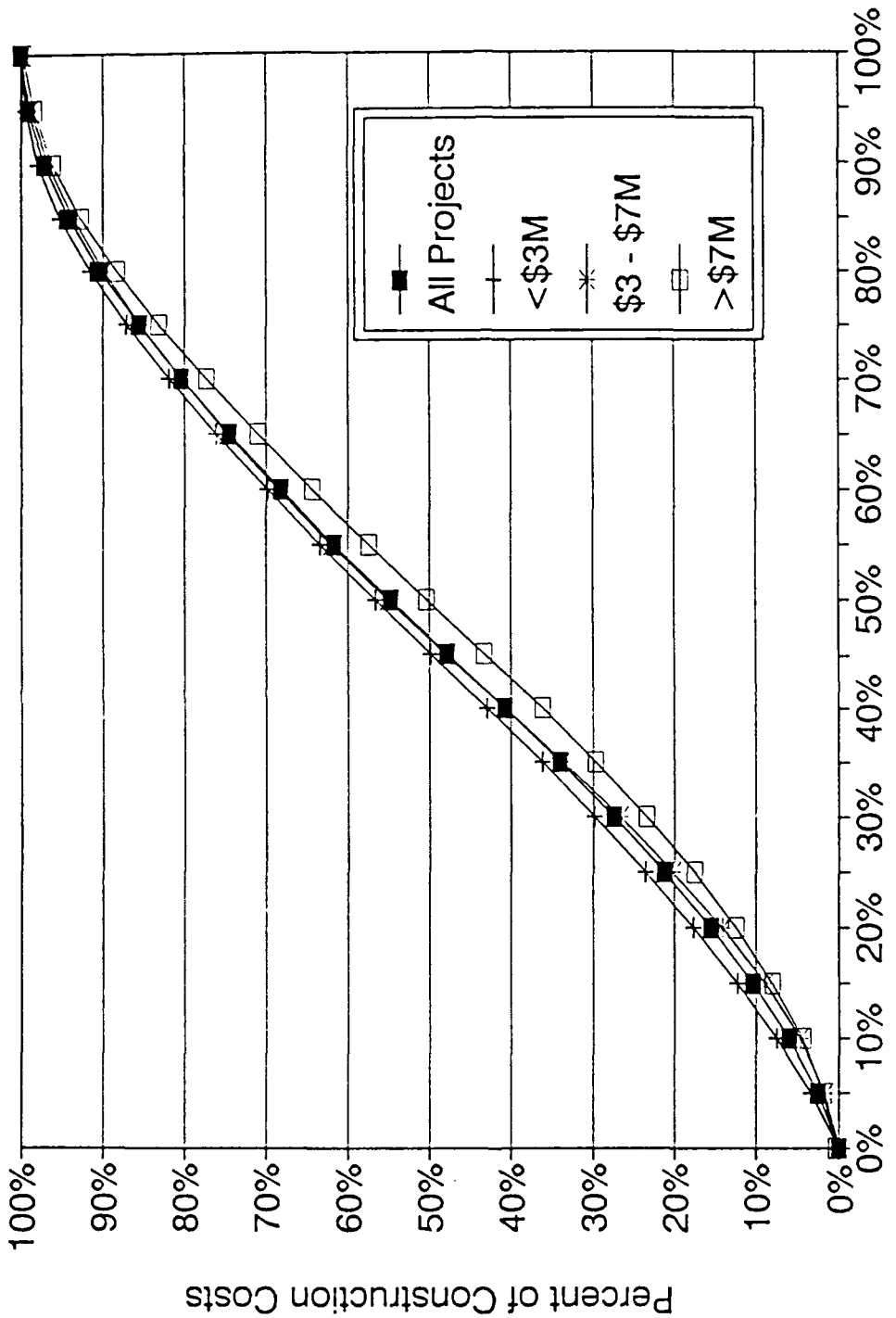


Fig. 9. "S" Shaped Curves

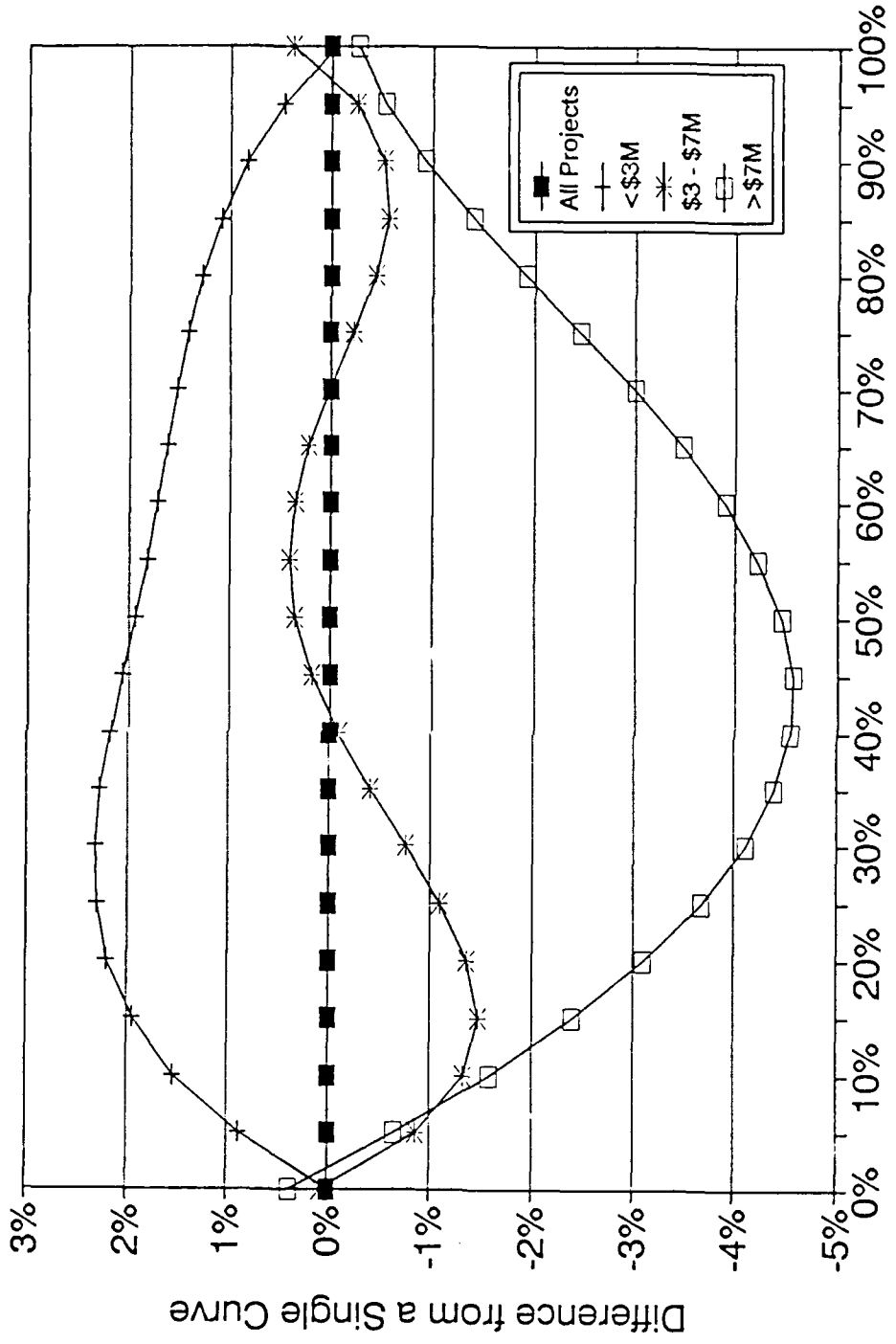


FIG. 10. Variations Between Curves

The Consequences

There were two very valuable items learned from this particular task. The first was in analyzing a large amount of historical data, in this particular case over 850 records, and running the records through a statistical package in order to develop a model. It involved more than just a collection of the data. It also involved running the data from one format, which was in a database format, into another format, a spreadsheet format, in order to review and use the additional graphical characteristics of the spreadsheet. From the particular spreadsheet file, I was able to take the data into a text file and to run a statistical package in order to come up with a fourth order equation to simulate an "S" curve. The second valuable item learned from developing the model was the computer programming required to generate such a report. Although I have done a considerable amount of database programming in the past, the use of a new version of a database program called Fox-Pro and using Quattro Pro was new to me in some of the characteristics that I used in each of the programs. Both Quattro Pro and Fox-Pro have just been released and are major enhancements to previous versions. The features of both programs far exceed any of the features of an earlier version of any spreadsheet or database programs on the market. Just the

programming and computer portions of this task were a valuable instrument in illustrating the importance of computer knowledge in the construction industry.

Contributions To Other Organizations

This particular assignment, although only meant for use in the construction phase of a project, could be expanded to include the entire phase of a project all the way back to conceptual design. In fact, the Administrative Division of the organization has reviewed the program and are actually pursuing the integration of such a program. The program would include all aspects of project costs from conceptual design and architectural fees through construction.

One main area for improvement of this program would be to look at the individual types of construction along with individual ranges of construction costs. The particular model generated, does not take into account a project that is a renovation compared with a project that is new construction. First, such a program variable would require additional input for each project. One of the main objectives was to use existing information already contained in the database files thus eliminating additional data entry. Second, renovations are typically less expensive than new work and thus can be categorized

by dollar amount. Third, there is another graduate student working on his Masters degree in the Construction Division and he is currently pursuing that particular issue along with doing the analysis on SAS on a mainframe computer at the A&M campus. It will be interesting to see his results when he finishes it later this fall.

Perhaps the main contribution outside of the organization could be that databases can be used for management decisions. Industries could use databases much more extensively than recent articles on the use of computers in construction indicate they now do. There seems to be a major emphasis in using computers for such things as knowledge-based systems, but there are not a lot of articles on the simple use of database and spreadsheet programs. Although the program code that I generated could not be used by other organizations without minor changes, it does prove that organizations can effectively develop a forecasting model. The only major change would be the equations that are used to generate the curve. Those equations could be generated by each different organization by running analyses on the particular projects. For example, architectural firms could benefit by such a program by allowing and giving the User an anticipated cost forecasting model for his particular project.

Summary Of Forecasting Model

This task took approximately six weeks from start to finish. However, the six weeks was not a continuous time span due to the fact that other managerial assignments were achieved within the organization, such the parking garage and wave tank schedules, and doing daily inspections for some of the inspectors that were absent. Even when finished, several minor corrections and new features were added during the seven months of actual use. I wrote the program code and database files to work for fiscal years 90, 91 and 92. However, it would require minor changes each year to drop a year like 90 and add a year like 93. Since writing the program code, I have changed the program and files to work on any three years where the user identifies the first fiscal year. This change negates the yearly program code changes. After a half a year of use, Mr. Chapman believes we are well within 10% of forecasting actual construction costs two years into the future and it can be done in less than ten minutes on over 40 projects.

JOB ACCOUNTING SYSTEM

Objective - Develop A Job Accounting System

The objective of this assignment task was to develop and implement a job accounting system in the Construction Division that would track actual inspection costs for each contract.

Task Description

In the summer of 1988 a Steering Committee was appointed to evaluate the construction and maintenance management effectiveness at Texas A&M University. The committee was to come forth with recommendations regarding feasible mechanisms for increasing the efficiency and effectiveness of the administration of the construction and maintenance program.

One recommendation that the steering committee made was for the development of the detailed cost accounting system. The goal would be to determine the validity of the fees, opportunities of savings, and to establish guidelines regarding appropriate reserve balances (Steering Committee Report). To validate fees, the organization needed to develop a detailed job accounting system in order to track their actual expenses for the construction project.

With the use of time sheets in recording time spent

on different activities and job classifications, the organization will have a detailed cost accounting system. Through the use of various reports, the organization will be able to determine other things such as how much actual time they spend in the inspection process on a contract. They will also be able to determine if a project at Galveston costs more if the inspection is done from the office in Houston or from the office in College Station. The general consensus is that it costs more money to run the inspection out of the College Station office for some of the smaller jobs we have, especially those at some of the agriculture centers. It may be cheaper to hire a local firm to do inspections than to do it with in-house personnel.

Administration And Managerial Assignments

The only managerial assignment in this particular task involved working with various members of the organization to determine the different activities and job classifications with which they are involved. The work load was directed by the internship supervisor, Mr. Chapman. Mr. Chapman periodically reviewed the various stages of this task to insure that the development would be done in a usable form once completed.

The task was discussed with people from the

Administrative Branch and the Planning Division in order to determine what methods they might use for a job accounting system in their respective division. The administrative assignment was to develop a system that could be used not only for the Construction Division but also the whole FP&C organization. It would involve writing a database code in order to edit records and keep all the information in the data file. Besides the development of the code, the organization employees would have to be trained in filling out a time sheet correctly, using the activities and job code classifications that were developed. Finally, proper documentation of the code was very important so the code could be modified in the future.

Description Of Non-technical Problems

Most organizations have a method to track time that they spend on various activities. Such systems can be used or abused by the organization. As mentioned above, the purpose of this task is to justify and validate fees that the organization charges for doing construction on campus. It will also be used to see how much time is actually spent on different stages of the construction projects, including the direct costs of actual inspection, and the overhead. By having a time accounting system, the

Construction Division is able to track how much overhead it takes to run the organization.

The proposed job accounting system will not used for construction work assignments. It will not be used like a job assignment sheet is used in a construction project nor will it be used to give instruction to a worker on what they should do, where they should go, or how they should do their job. The proposed system that we are trying to develop is for record purposes only.

Construction costs at Texas A&M University System can be divided into three main areas:

1. Contractor costs.
2. Architectural design costs.
3. FP&C fees to handle construction.

The administrative division of FP&C has developed and implemented an accounting system for contractor and architectural costs. However, there is no system currently being used for FP&C accounting of the fees. The cost accounting system of FP&C is similar to a contractor's accounting system in that there are various activity codes with associated task codes.

After several evolutions, Construction Division has identified five activity codes. The first activity code would be a Contract Number, if it is awarded, or otherwise, the Project Number. The second activity code is training. The third would be general administration in

the organization. The fourth is general supervision in the organization. The final activity code would be off-time/nonproductive time.

Associated with the activity codes are task codes. For example, for off-time/nonproductive time there are ten tasks codes that could apply such as travel, vacation, sick leave with or without pay, comp time, holidays, leave, military duty, jury duty, and nonproductive time/other. General administration has twelve associated task codes and the other activity codes have various tasks codes associated with them.

The activity codes and task codes are important; however, accurate and timely information is needed in order to be effective in providing a usable product. If the information is not accurate or supplied in a usable form, then the entire accounting system has no real value.

The Method Or Approach To The Tasks

The first question as to whether or not FP&C even needs an accounting system was determined by Steering Committee's report. Next, since there are three divisions in the organization, would each division develop their own accounting system or could a joint accounting system be developed that all three divisions could use? It was determined that the Construction Division would develop an

accounting system which could be adapted and added to for the other two divisions use. The additional activity codes could be developed with tasks codes and the entire accounting system would record and manipulate data into generated reports that could be used throughout the organization.

The third step was to develop the actual activity codes and tasks codes mentioned above. The fourth step was the actual development of the accounting system. This includes the data base code for editing, adding and printing reports. Rather than complete the entire coding and computer process, Mr. Chapman decided that the Construction Division would begin collecting data by having the Construction Division employees fill out time sheets.

The fifth step was to develop a very simple time card that all employees could fill out on a daily or weekly basis. It was determined that a weekly basis would not provide an accurate accounting data compared to a daily entry. Therefore, a daily time card system which would be turned in on a weekly basis was used. All employees in the Construction Division were given instructions how to fill out the time sheet with a list of all activities and task codes.

The sixth step would be to start collecting all the

data and input it into the data base.

Step seven would be the generation of reports used for managerial purposes.

Step eight involves the merging of costs data and employee payroll data with the time data collected.

The final step, was the removing the "bugs" and making final corrections to the accounting system.

Sources Of Information Required To Perform Task

The main source of information required to perform this task was the job descriptions of the employees. The job descriptions contained the tasks associated with their job. The second source of information was a literature research of various accounting systems that are used in the construction industry. But there were no accounting systems in the construction industry similar to the one FP&C is implementing. Besides job descriptions and library references another main factor in determining the activity code and the task codes was the actual internship itself. In the preceding eight months of internship, I was able to accomplish most of the duties, assigned to the employees of the Construction Division, which are the task codes used in preparing the accounting system.

Discussion Of Pertinent Information

In order to develop the database file structure, the intern supervisor and I had to decide what information was to be derived from using this accounting system. Various reports were developed and generated in order to present the information in a useable format. It was determined that each record in the database file would contain the following fields:

Employee's name
Date
Activity number
Task number
Time
Hourly rate for the employee

The various fields in the record were needed in order to prepare the numerous reports required by the intern supervisor. As mentioned earlier, a list of activities and tasks were developed based on employee job descriptions. Since contract or project numbers are four digits, a four digit activity code was used. A majority of the activity entries are a contract or project number; however, there are four additional codes in order to handle overhead or management time. The four additional activity codes are:

6000 - Training
7000 - General Administration
8000 - General Supervision
9000 - Offtime/Non-Productive Time

Associated with each activity is a task. From a list of job descriptions and discussion with various employees,

the list of tasks was developed (See Table 2 on the following page.) The task numbers are not sequential for two primary reasons. First, a three digit number is selected so that the first digit can be used to represent a division in the organization and the second and third numbers represent the actual task number. Thus a number of 122 represents the task of computer maintenance in the Construction Division. All 100 and 200 number tasks represent the Construction Division. Second, the numbers are not sequential so that future task items could be added.

If the Planning Division and the Administration Division implement the cost accounting program, additional activity and task codes may be added to the available list of codes. Both divisions have expressed a desire to review the program for possible implementation.

TABLE 2. Time Accounting Tasks

OFF/NON-PRODUCTIVE TIME
101 - Travel
102 - Vacation
103 - Sick Leave(w/pay)
104 - Sick Leave(no pay)
105 - Comp Time
106 - Holiday
107 - Leave (other)
108 - Military Duty
109 - Jury Duty
110 - Non Prod. time(other)

GENERAL ADMIN
115 - Monthly Status Report
116 - Maintaining contr. subm./drawings
117 - Posting Addendums
118 - Office Mail
119 - General Clerical
120 - Travel Administration
121 - Maint Database files
122 - Software Maint.
123 - Writing programs
124 - Modifying existing software packages
125 - Purchasing and Repair office equip.
126 - Maintaining computer inventory

PRE - AWARD ACTIVITIES
140 - Design Reviews
141 - A/E Selection

CONTRACT ADMINISTRATION & QUALITY ASSURANCE
150 - Pre-Construction Conf
151 - Progress Meetings
152 - Inspection
153 - Daily journal of project activities
154 - Coordinating materials testing
155 - Reviewing submittals/Sched.
156 - Verifying payment
157 - Review manuals
158 - Coordination
159 - Project Management

MECHANICAL TASKS
170 - Inspect mech. work
171 - Reviewing bidding documents
172 - Conducting above-ceiling inspections for mechanical work
173 - Testing and balancing consultants coord.

ELECTRICAL TASKS
180 - Inspect elect. work
181 - Reviews bidding documents
182 - Conducting above- ceiling inspections for electrical work
183 - Test elect. systems consultants coord.

CIVIL ENGINEERING TASKS
190 - Inspect civil work
191 - Reviewing bidding documents
192 - Reviewing material testing laboratory reports

CONTRACT CHANGES
200 - Revisions/C.O. coord. or administration
201 - Cost estimates for contract changes
202 - Claims Administration
203 - Verify resources

POST ACCEPTANCE ACTIVITIES
210 - Punch list follow-up
211 - Warranty Admin
212 - One year inspection

TRAINING
220 - Attending formal training course
221 - Continuing Education(on campus)
222 - Training Admin

A major hurdle for the entire accounting system is how the employees will use the time card (See Figure 11 below) and how employees interpret the use of the time cards by management. Some employees consider the use of

WEEKLY ACTIVITY ACCOUNTING SHEET

Name - _____ Week of - _____

Activity	Task	Total Time	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.	Sun.

FIG. 11. Weekly Activity Accounting Sheets

these time cards as a threat against them and that management will use as a tool against them. Other employees have already mentioned the fact that they would just pencil in any information. To overcome this hurdle,

the internship supervisor, Mr. Chapman, decided to have the employees fill out the time sheets for a trial period of three or four weeks and then analyze the result of their time sheet cards to see how the employees are filling them out.

During the time frame of three to four weeks Mr. Chapman made periodic inspections of the time sheets to make sure the employees are filling them out on a daily basis and not waiting until the end of the week or the beginning of next week to fill out the previous week time cards.

Time cards were simplified so that it should only take a matter of a few minutes each day to record the activity of the employee on his time card. Since some employees will not use or in most cases, even see the data collected from the time cards, it will be up to management to show periodically what the information is used for and why it needs to be collected.

In addition to the job accounting program, I wrote an additional program to edit and maintain employee information such as their hourly rate. The hourly rate is adjusted to include salary, workmen's compensation, social security, insurance, retirement funds and longevity. Since the hourly rates calculation change periodically, the staff program can be used to update each employees

hourly rate. The staff database file is used by the accounting program to extract employee names and pay information. I did not install this program for general use on the network since it contains sensitive information like salaries. Therefore, I wrote an independent program for Mr. Chapman and installed it only on his machine. The accounting program and files were installed on the network for use by all employees but the staff program can only be accessed by Mr. Chapman.

The Consequences

There is the debate as to whether the use of the job accounting system in the Construction Division will or will not enhance management's perspective in the organization and in the construction process. I maintain that it will enhance managements perspective for the following reasons:

1. The information can be used to validate the Construction Division fees.

2. The information will help management make decisions whether or not to do agriculture station inspections from the main office or relocate several employees.

3. The information can be used by management on personnel decisions.

4. The job accounting system will offer management a tool to look at indirect and direct costs of construction inspection.

For example, if several projects are added to the

existing workload, management may have to make the decision to either hire more employees or readjust the work load of several of the existing employees. There really is no direct measure of time spent inspecting the job or directly associated with construction, versus overhead.

Contributions To Other Organizations

Although this task is only meant for the Construction Division, it can and may be implemented in the other two divisions in the organization. Besides the use of the job accounting system as a direct means of recording costs associated with a different path of construction, the information collected can be used by managers outside of this organization.

In a small sense, construction inspection and teaching are similar. For example, when someone outside the teaching field ask you a question like, "How many classes do you teach?" and you respond with, "I teach three graduate courses", the outsider is often skeptical. A person outside the teaching field considers your response an admission that you, the teaching professor, are only in the classroom about ten hours a week. To him, this means that you have a lot of free time available for choice activities since you only work for about ten hours

a week. Construction inspection is similar. Most people only see an inspector a few minutes a day because they are not with the inspector the full time. Most people outside the construction industry do not realize the preparation for construction inspection. In the job accounting system, reports and charts can be made to illustrate, in a very easily readable format, the different activities and tasks that go into the construction system.

Finally, the accounting system can be used as an auditing tool to show the effectiveness of the organization.

Summary Of The Job Accounting System

Although still in trial use, the job accounting system has met the goals of the intern supervisor, Mr. Chapman. He has reviewed initial reports and has elected to continue having employees record time sheets. In addition to satisfying Mr. Chapman's goals, the job accounting system satisfied the recommendation of the Steering Committee to establish an accounting system.

CONSTRUCTION PROJECTS

Objective - Construction Projects

Task three involved the day to day inspection and management of two construction projects - the Offshore Technological Research Center and the Southside Parking Garage. It encompasses all aspects of the construction from the bid opening through final acceptance.

Tasks Description

The first project was the construction of an Offshore Research Technological Center (ORTC) to be located in the Texas A&M University Research Park, College Station. This center is an integrated research, education and technological transfer effort achieved through sharing and exchanging intellectual concepts dedicated to the enhancement of the U.S. Offshore Industry. A considerable amount of research effort will be devoted to marine hydrodynamics. The initial research of the center will be focused on deep water technology. The facility will be the only such facility in this country for deep water technological research. It will provide faculty and students at Texas University, Texas A&M University and industrial petitioners with opportunities to get hands on experience in deep water technology research and enhance research in the U.S. offshore Industry. The facility will

be a laboratory building with approximately forty thousand square feet of floor area including space for model shops, utility rooms and data acquisition in control rooms. The main component of the facility is the 150 feet long, 100 feet wide and 20 feet deep tank with a center pit (15 ft x 30 ft) 35 feet deep. In addition to the tank, the facility contains office space, conference rooms, shops and restrooms. A slow speed carriage and large water recycling pump system was also installed within the building. The facility is a steel structure with concrete tilt-up walls and finished with brick matching other buildings in the research park.

The second project, the Southside Parking Garage, is a four-level parking garage constructed using post tensioned concrete. The Southside Garage is the second 2000 car garage built on the main campus. The primary purpose of the Southside Garage is to relieve parking problems for the students in the dorms near the garage. Vehicle access from parking level to parking level is via wide, straight run ramps with parking on each side of the one way traffic lane. Exterior walls are made of modular, filler faced brick and finished masonry between parking levels. Exterior stairwells and elevator hoistways are glazed for security. A majority of the initial construction costs were associated with the detailed

foundation. All newer facilities at Texas A&M University have reinforced concrete piers drilled down to a suitable bearing strata and reinforced concrete grade beams spanning from pier to pier. In the College Station region facilities need piers and reinforced concrete grade beams spanning from pier to pier. In my twelve years of Air Force experience, I have never dealt with reinforced concrete piers. The new experience was rewarding and challenging. I have also not been associated with post tensioned concrete floors, walls and beams.

Another interesting aspect of the Southside Parking Garage was the aesthetics of the garage. Both the Southside and the Northside Parking Garages' appearances were designed to harmonize with the existing facilities. There is no doubt that there was a great amount of study of various parking structures in Texas in order to build a structure on the Texas A&M main campus that would fit into the existing architecture.

Both the ORTC and the garage began and were scheduled to be finished during the internship. The one-year construction period enabled me to observe the entire construction process. Although the focus of this assignment task was on the two projects mentioned above, throughout the year I worked on various elements of additional construction projects.

Administration And Managerial Assignments

The administrative and managerial assignments included the tasks in the job descriptions of a Project Manager and a Construction Inspector. As shown in Figure 2, page 9, the Project Manager works directly for the Chief of the Construction Division. Under the Program Managers are several Construction Inspectors. In addition to the Project Manager and the Construction Inspector, there are other staff members who help with various aspects of the construction phase.

Mr. Cole was assigned the Project Manager duties for the Offshore Technological Research Center and Southside Parking Garage. I worked under his daily guidance and subsequently assumed his duties in his absence. The Construction Inspectors were Ernie Sims on the ORTC and Jody Rasler for the Southside Parking Garage. When Ernie Sims or Jody Rasler were on vacation, I assumed the roles of the Construction Inspector.

Besides assuming the duties of Project Manager or Construction Inspector I did the computer scheduling of both projects and worked on numerous change orders, revisions and claims. These duties involved coordinating with several other members of the organization.

Description Of Non-technical Factors

Construction Project Management inspection is by no

means a clear-cut precise procedure. There are too many other non-technical items that influence the effectiveness of the construction program. These factors are not unique at Texas A&M; however, in my one year internship I was able to see how they influence the construction process. Items that have an impact on construction are:

1. The Design/Construction System.
2. Rush Projects.
3. Design Reviews.
4. Project Scheduling.
5. Employees.
6. Alternatives.
7. A/E's.
8. Locality.
9. User Coordination.
10. Financial Arrangements.
11. Weather.
12. Cash Flow With Contractors And Subs.
13. Computers

The Design/Construction System

The design/construction system at Texas A&M is different from any other construction system I've been associated with in the past. The entire process is initiated by a User preparing the justification. In the case of the ORTC, the User, Mr. John Flipse, Associate

Deputy Chancellor for Engineering, prepared the justification. Not only did Mr. Flipse prepare the justification, he arranged for actual financial support. With efforts between Texas A&M University and the University of Texas at Austin, Texas A&M was awarded a grant from the National Science Foundation.

Justification is presented to the Department of Facilities Planning and Construction where the Facilities Administration Division prepares the documentations for the upcoming Board of Regents meeting, specifically the Building and Planning Committee. During the next Board of Regents meeting the project is discussed to determine whether or not a Program of Requirements should be prepared by the Facilities Planning Division.

Once the Board of Regents approves the project financial arrangements are made for the Facilities Planning Division to begin and complete the Program of Requirements Book and at the same time the Facilities Planning Division will select an A/E.

At the next Board of Regents' meeting the Program of Requirements is presented and, if approved, the results of the A/E selection are presented to the Board of Regents where an A/E will be selected to continue with the design. Once a Program of Requirements and the A/E selection have been approved, the A/E begins the actual design of the

project.

For most projects, 50%, 90% and 100% design reviews are conducted by the User, Facilities Planning and Construction personnel, and A/E's. There may be additional design reviews depending on the complexity of the project. Once the A/E has completed the design, cost estimates are prepared and updated at each design review stage and the project is once again presented to the Board of Regents for additional approval. Once the additional approval has been given, the project is sent out for Invitation for Bids. Bids are collected by the Facilities Planning Division and opened publicly and the results of the bids are presented at a future Board of Regents meeting. Up to this point, the lead player in the project, besides the User, is the Program Manager from the Facilities Planning Division.

Depending on the A/E's cost estimate and the bids received by various contractors, the project will either be awarded as originally developed or the program scope will be adjusted to reduce the estimated cost of construction. Once the Board of Regents approves the project for construction, the entire project becomes the responsibility of the Project Manager in the Facilities Construction Division. Although there is still some involvement from in the Program Manager, from the Planning

Division, it is the Project Manager, who has complete contracting responsibilities, including the financial approval for payment.

Once construction is complete, the User and Construction Division personnel will conduct a prefinal and final inspection of the facility before occupancy. Construction Division personnel will assist the User in maintaining and receiving operations and maintenance manuals, warranties and final blue prints. One year after final completion of the project, the Construction Division will hold a One Year Inspection with the User Coordinator, the A/E, Physical Plant personnel and the Contractor.

A majority of the construction at Texas A&M University follows the procedures mentioned above; however, there are some projects that have deviated from this norm. The ORTC is a primary example. Mr. Flipse initiated a purchase order through the University System to have a Canadian Contractor, Davis Engineering, install the one million dollar wave equipment. Although the Construction Division is not directly involved with the Purchase Order, because of the nature and extent of the work involved, the purchase requires additional coordination. In addition to coordination there were several conflicts that had to be resolved. For example, the A/E for the design of the ORTC facility did not

include the hydraulics to run the wave equipment, nor did Davis Engineering have it in their contract. It was simply an oversight by the designers and engineers and not discovered until the construction phase. Therefore, a change order had to be given to install the hydraulic equipment in the facility or Davis Engineering had to be instructed, through an additional purchase order, to install the hydraulic equipment.

Although the construction system at Texas A&M does have some minor problems it is a good system and construction does proceed smoothly. The only minor change that I would recommend is; when a project is bid and awarded, there should not be such a distinct discontinuity shift between technical responsibilities of the Planning Division and the Construction Division. Technical expertise should remain with the project from initial concept of design through final completion. In addition to technical expertise, the Program Manager for the Planning Division needs more involvement in the construction phase of project and, vice versa, the Project Manager in the Construction Division needs more involvement in the project when it is in the design stages. There are three methods to accomplish this change. One would be to form another division called the "Technical Division" which includes electrical, mechanical

and civil engineers who would follow a project from conceptual design up through final completion. Second, more of a team concept could be formed between the Project Manager, the Program Manager, the A/E and the Contractor. Third, a major organizational change could combine the Construction Division and the Planning Division. Although no system is perfect, the system would improve by incorporating one of the methods above.

Rush Projects

Rush projects are the second non-technical problems that occur with the Construction process. There are several projects currently under design which are being rushed through the design process. For example, the Special Events Center is a specific example of a project being rushed through design. It is uncertain what kind of problems will arise out of a project such as the Special Events Center; however, it can be expected that problems will arise simply because the project is being designed in less than one year. In addition to the Special Events Center, the existing Beef Cattle Center has to be relocated due to the Special Events Center's siting. The new Beef Cattle Center relocation causes a rush design for that project. A more significant potential problem concerns the MSC Expansion project, especially the Parking Garage and the Two Story Office Complex in Lot 60.

Currently, there is discussion that the 12th Man Foundation will be moving into an area that was going to be roughed-in as a catering kitchen. The Project Manager has already asked the Contractor to revise his concrete pour schedule and to keep that area undisturbed until it can be totally redesigned. The approximate cost of the new construction is $700,000 which will include a total revamping of the area and a change order to the contractor for the new work. Approximate time for design was less than three months and required modifications to several existing drawings. The internship will end before the work is accomplished but it will be interesting to observe and to find out what kind of impacts the rush design had on the project. Rush design or rush project change orders always have a negative impact on the construction and should be avoided if at all possible. Besides a negative impact, there will be an extra cost associated with such rush projects.

Design Reviews

The third non-technical problem centers around design reviews. Design reviews are complicated by the fact that the Planning Division does not use standardized specifications. There have been numerous discussions in the organization on the use of standardized specifications but, to date, they are not used and there have been

several negative impacts.

Design reviews are critical; however, they have not been given the emphasis they deserve by all parties concerned. Some Construction Division personnel do not have the desire nor the time to conduct a Design Review which they would like to do and which should be done. Part of the problem stem from personality conflicts within the organization. Other problems occur when the Architects and the Program Manager in the Planning Division fail to recognize constructablity or even functionability items that the User requested. There have been many instances where items have been left out of a project because of the items aesthetics properties. Architect aesthetics properties in the Southside Parking Garage overruled a User requirement. The User had requested a dumpster to be located near the shop area in the southeast corner of the facility. However, the Architect and the Program Manager overruled the dumpster because it would not be aesthetically pleasing to the facility at the Parking Garage. The nearest dumpster is located on the extreme northeast side of the facility near the dormitories. This is a totally unacceptable solution for the User.

There have been other items in the Southside Parking Garage, ORTC and other projects is which a more thorough

design review would have caught the situations which caused either change orders or unfulfillment of User requirements. Unfortunately, there are some items that were caught in the design review, yet for some unknown reasons, they were not corrected in the design by the A/E. Design reviews are very important and require the proper emphasis and coordination by all players.

Project Scheduling

Greater use of project scheduling was another item identified by a Steering Committee as needing more emphasis in the construction process. Shortly before I started the internship, a section was included in the specifications to have the Contractor develop and use project scheduling techniques and reports. Including scheduling requirements in the specification's general provision is the first step; however, project managers and inspectors should, but do not, use the information provided by the contractors. Project scheduling, like design reviews, have not received the necessary emphasis by all employees of FP&C. Project scheduling is a valuable management tool to assist program managers, project managers, inspectors and contractors in the construction process.

In the one year internship, I was able to use project scheduling techniques to assist management in making

various decisions for different projects in the system. Because of the complexity of having two contractors working in conjunction on the ORTC, the Construction Division issued a change order to Gamma Construction in order to have the Construction Division assume all project scheduling responsibilities. There were other factors that influenced the decision to have the Construction Division assume project scheduling for this project but the major emphasis was to have better control of the scheduling coordination between the two contractors working on the project.

There is no doubt that project scheduling has an important impact not only in the construction process but also in the design phase. For example, when the MSC project was in the design phase it was determined by using a project scheduling package, that the design and thus the construction, could not occur in the order that the Architect presented the User. In other words, the design had to be modified in order for the work to occur at the proper stages of time.

Project scheduling could be a very valuable management tool but until the organizational personnel understands that, project scheduling will continue to be a problem in the organization.

Employees

The fifth non-technical problem concerns the employees in the organization. The Facilities Planning and Construction organization is no different than any other organization that does construction in the sense that there are many types of personality conflicts and employee problems within the organization. For the most part, problems are minimal in nature; however, they do affect the construction process. Problems are not associated within just the organization; problems also stem from personality conflicts outside the organization that influence the construction process. There are no problems unique to this organization, but there are two problems that are severe which can be corrected.

The most severe employee problem is the lack of competency or the lack of desire to do the job they were hired to do. There have been too many instances in the Planning Division and the Construction Division of problems with construction because of lack of competency or the fact that a Construction Division employee did not make the effort to do what should have been done. For example, to put large concrete slabs in without expansion joints or felt around the columns is ludicrous. Granted, codes may not require a lot of construction joints, yet in some instances too many are put in; nevertheless, construction joints or expansion joints are required to

alleviate the concrete from cracking. Recently, there was roadwork done that was totally unacceptable yet was passed by an inspector. It should be noted that the inspector is not totally at fault. The designer is equally at fault because the inspector simply constructed the road according to the plans and specification. Not all inspectors have the technical expertise to handle all aspects of the construction.

Personality conflicts between the Construction Division and the Planning Division are extremely severe. They are severe to the point that several members of each division will simply not even talk to anyone in the other division. Such stubbornness can definitely not aid the construction process.

As mentioned earlier in the report, there are people outside the organization that have an influence in the construction process but do not understand the process well enough. Decisions are made in the construction process that should not have been made but the people making those decisions do not understand all the factors involved. An example is the issue of the trees at the MSC project. The decision was made outside the Construction Division office that the trees would be relocated. Needless to say, the trees did not survive and $135,000 was wasted. As the result of these employees problems,

management has to spend a majority of its time on "people problems" instead of "technical problems." Management is aware of these problems and throughout the year internship has taken steps to reduce employee problems.

Alternatives

The Sixth non-technical factor is the use of alternatives in construction. If in the Program of Requirements or in future design it is determined that the scope of the project may be too large for the financing available, alternatives are developed. Therefore, there are up to ten different alternatives that are included with the project. For example, the ORTC was originally to be a 150 foot by 100 foot by 15 feet deep pool; one of the alternatives was to increase the depth to 20 feet.

In some projects alternatives are fine, but in the case of the ORTC, the alternative caused additional problems in the construction phase of the project. Whenever alternatives affect the design of a project, especially its structure, changes have to be incorporated into all aspects of the drawings. In the case of the ORTC the additional five feet depth in the pool was not reflected in all the drawings. Accordingly, change orders had to be issued to correct the problems. From discussions with other project managers and inspectors in the Construction Division, this is not the first case

where the use of alternatives in the construction has caused a severe problem in the construction phase. Architects do not resolve all the alternatives in the same fashion that they actually design the facility itself. In defense for the Architects some alternatives are to hard to incorporate into all the drawings. Designing alternatives are compounded by the fact that most architectural firms hire consultants and the alternatives affect several engineering disciplines simultaneously.

The use of alternatives are valuable when they can be distinct from the facility like landscaping alternatives. For example in the Southside Parking Garage, one of the alternatives was to put additional parking on the southeast side of the facility. That particular alternative has very little impact on the rest of the facility and would cause no problems if the alternative was or was not selected. The major problem occurs when an alternative has a direct impact on the facility itself such as deepening the wave tank of the ORTC from 15 feet to 20 feet. Such alternatives can, and often do, affect the civil, structural, electrical, and mechanical drawings. The Architect must ensure that the alternatives are reflected clearly in the specifications and drawings.

A/E's

The seventh non-technical factor is the selection of

the A/E for the project. The current selection process for A/E's is very good and fair. The process starts with selecting six A/Es for the particular project and inviting each A/E firm to present their project manager and consultants. My internship supervisor has a direct chair and vote on the selection committee. During his absence I was able to participate in a selection committee of an education facility for the Galveston campus. The process is tedious; nevertheless, it is a good process and in most cases a good A/E is selected for the particular project under consideration.

There were only two minor problems I encountered in the A/E selection process. As mentioned earlier, there are some personality conflicts within the organization and these are carried over to the selection process. The second problem is with the A/E firm selected. The selected firm is not a problem of the selection process but a problem with the fact that the process may have selected an A/E that is not the best qualified for the project. For example, for the Southside Parking Garage, an excellent civil engineering firm was selected as the primary architect for the project. The civil firm hired an architectural firm to assist in the drawings; however, there were some problems associated with the fact that the civil firm had the lead role in the project and were not

experienced in that role. There were several instances where architectural drawings and structural drawings simply did not match. If an architectural firm had the lead role this may have been caught. There were several other instances where the civil firm, which is a very good firm, had not incorporated some things into the design drawings that other architectural firms had incorporated. Although the Parking Garage is primarily a civil engineering structure, these minor problems resulted in future change orders. For the most part, the majority of the architects that I was associated with during the internship are good architects and in most cases will be hired again by the A&M System for future jobs.

The A/E presentations were noteworthy. I was amazed that every presentation was totally different. I was also surprised when one A/E's major point was, "I am a good A/E, you should hire me." Other A/Es had a very good presentation and they were generally the ones who ended up with the design.

Locality

Locality of construction or locality of the architects is another problem with the construction process at the A&M University. Since Texas A&M University System is a large University System in a small town, locality is a problem. Because the main campus is in a

small community, most architectural firms are two to five hours away. Therefore the architectural firms do not spend a great deal of time looking over the construction projects. In addition, the Construction Division is not able to assign full time inspectors and project managers to some of the jobs off the main campus such as those at Stephenville, Corpus Christi or Galveston. In most cases the Construction Division will move an inspector to the site full time but the Project Manager comes from College Station on a weekly or biweekly basis. This can cause additional problems with the design process and getting things done either by the Inspector or the Project Manager or even a Program Manager from the Planning Division. In most cases the Program Manager from the Planning Division, seldom goes to the construction site once the project is bid.

User Coordination

In my previous construction experience (Saudi Arabia), user coordination had been a very significant problem. However, at Texas A&M University user coordination is very good for the most part. User coordination on the MSC project is perhaps the best I have ever seen. The only problem I have been associated with is the Southside Parking Garage. The User Coordinator failed to make timely decisions which became critical and

caused additional problems. The majority of the employees in the Construction Division view user coordination as a valuable asset in the construction process.

Financial Arrangements

The various financial arrangements necessary for construction at the Texas A&M University System present a few minor problems in the construction process. There are numerous ways in which financial arrangements are made for construction on the campus. One already mentioned, the ORTC, is where the User obtained a grant from the National Science Foundation. Besides outside sources, there is the Athletic Department, Transportation Department and the University have their own funds to use for construction. Financial problems occur at two different stages in the construction process. The first occurs when the project has been designed and the architect makes an estimate. At that point in time the estimate may be larger than the financing. The next opportunity for problems occurs at bid opening and the bid exceeds the estimate and financing. This occurred on the Woodbine Building, the new System Administration Building, which the architect estimate was $7,500,000 but the bid came in at $10,000,000 or $2,500,000 over the estimate. When that occurred there were two options. Redesign and lower the scope of the project. This is what they did on the Woodbine Building.

The other option would have been to go ahead and find additional funds to support the construction.

A second problem can occur once the facility is being constructed and there are changes due to user requirements or design omissions. The ORTC had several user changes and design omissions that caused the contingency amount to be exhausted. In this case the User is required to locate additional funds to do the changes requested and support change orders required due to design omissions. In most cases, user changes are not a problem since construction of the changes will not take place until the arrangements have been made for additional money or enough money to handle the change is currently in contingency. A major problem occurs when there is a design omission. As in the case of the ORTC, users do not understand design omissions and why they should fund them. It is unfortunate that a design omission or some kind of error occurs; however, paying for design omission change orders during construction saves the User and the University money by not incorporating design omission responsibility in an architectural contract. It is possible to have the architect be responsible for design omissions but he will increase his fees. The policy of the Department of Facilities Planning and Construction is not paying those increased fees to the Architect initially but rather when

they occur in the construction process. Having dealt with military projects in the past I was very surprised to see the very low amount of contingency that is allocated toward the construction during a construction project at the University. The ORTC was the only project where the contingency balance was exhausted. There was an alternative to put in a wave absorber; however, due to the large amount of money ($80,000) the alternative was not exercised in the contract. Now 10 months (two months before completion) into the project the User would like to add a wave absorber. The User was required to locate additional money to pay for it.

Weather

The eleventh non-technical problem associated the construction is the weather. No matter where construction is done, weather can be and often is a problem in the construction process. Weather clauses are included in the general specifications to allow the Contractor a certain number of weather delays based on rainfall historical data in a given month. Besides rain, the only other time the weather becomes an issue is when severe cold would stop construction like a concrete pour.

Weather problems were a key issue on the parking garage. The garage had a one-year construction time limit with no time extensions. The contractor was paid $750 a

day in order to accelerate his schedule if he was delayed. Actual weather delays were often disputed between the contractor and our office resulting in lengthy claim meetings.

Although there were other weather problems, the current procedures were adequate to handle them.

Cash Flow with Contractors and Subs

One problem that I read about and which was discussed in the classroom but have never been involved with, is contractor or subcontractor cash flow problems. In the Southside Parking Garage, the steel reinforcement subcontractor had a serious cash flow problem and went out of business. He was also over extended and did not have enough workers to keep up with the job, so Argee, the Prime Contractor, did not pay him. This only compounded his cash flow problems and he had no recourse but to walk off the job.

A subcontractor gets his money from the prime contractor anywhere from two to four months after the work is actually done. Since most material suppliers will only carry someone for approximately thirty days, it can cause serious cash flow problems for the subcontractor. In the case of the parking garage, the problem could have delayed the overall project had it not been for the fact that the concrete subcontractor picked up the steel reinforcement

subcontract. The prime contractor was required to pay additional money for the new subcontract. This additional cost was an item between the Contractor and his subs, not the University. The University's only concern was that the project would not be delayed. In most cases, a problem of this magnitude results in delayed completion dates and liquidated damages.

The ORTC experienced another cash flow problem which caused concern for the University. A subcontractor, who was to supply the steel for the facility, was having financial problems with his main steel supplier. As a result, the subcontractor folded, leaving Gamma, the Prime Contractor, the responsibility of finding additional suppliers for the steel they had not received. The subcontractor's bid to do the work was so low that Gamma had to absorb $60,000 to find a new steel fabricator and/or supplier. Once again, it was no problem for the University except that it did delay the final completion date.

Computers

The Construction Division utilizes several data-based programs to maintain and record information of the construction progress of projects in the Texas A&M system. Such information is a tremendous benefit for project managers and inspectors in accomplishing their duties as

well as assisting management in making decisions. With the use of network computers, Construction Division Personnel can receive information in just about any detail on any project they so desire. They can view status of contract time, review construction contingency, add, edit, delete contract revisions, search for project numbers, A/E, Contractors, etc., look at warranties, payments to the contract and other utilities to help them with their duties. Even though computers are used in the Construction Division, they are not used to their whole potential. There are still too many employees who want nothing to do with the computer. Computers cannot be forced upon nonusers. In time, more and more users will utilize the computers. The only requirement for the Construction Division is to ensure computers and software are available. To date, the organization has done an excellent job in acquiring computer hardware and software. The only recommendation is to begin a small yearly replacement cycle in order to replace existing old and broken equipment.

The problems mentioned above are not new and unique only to Texas A&M University; however, these are problems that need to be frequently discussed in a classroom environment.

In defense of the organization, especially the

Construction Division, I feel that with the work load they have and the different aspects of the construction process they deal with, they do an extremely fine job in getting the User a finished product that is usable and for the most part, on time.

The Method Or Approach To The Task

The best approach and the one I used to accomplish the Project Management in the two projects, was to follow the Project Managers and Inspectors on their daily routines for several months. Besides following project managers and inspectors, I tried to learn as much about the organization and entire system as I could. I attended several Board of Regents meetings, several Planning meetings, discussed several issues with the Administrative Division and spent a lot of time with the different members in the Construction Division. The employees in the Department of Facilities Planning and Construction were very supportive of the Internship program, making my task much easier to fit in and to work side by side with them on the various projects. Within several months I was able to grasp the duties and responsibilities associated with the members in the organization. Since then it has been a pleasure working with them under various projects and handling problems that arose.

One of the most pleasurable yet most demanding months of the internship was when the Project Manager, George Cole, went on vacation for the entire month of May. Not only was I able to assume full responsibilities for Project Management of the Southside Parking Garage and ORTC, but I also assumed full Project Management responsibility for the MSC construction project and the Bizzell construction project. During that month I was able to take part in just about all aspects of construction and any associated problems. During the month I also conducted a one-year inspection on a dormitory project. Needless to say, the entire month went by quickly and it was a pleasurable month dealing with all the different aspects of construction from handling claims all the way to accepting finished work.

Sources Of Information Required To Perform Task

There are two major sources used in the performance of the task. The first source was the academic work I had prior to the internship. Every class I took at Texas A&M University made an impact on my internship in dealing with the task of Project Management. I dealt with financial matters, accounting matters, labor relations problems, cost estimating, project scheduling, communication, philosophy problems, soil stabilization problems,

construction techniques and system engineering issues. Every class I took at Texas A&M University has had a direct bearing upon decisions that I made while being a Project Manager.

The second source of information used was my previous experience. Twelve years of experience in the Air Force dealing with construction was a definite benefit for this internship. I was able to enter the job and step in knowing a lot about the paper work and inspection itself. Most of the organization at Texas A&M University is following along the same lines as the military organization during construction periods. There are some minor differences but the overall organization and the method is the same. The internship would have been significantly harder had if I had not had prior experience.

Discussion Of Pertinent Information

Discussion of pertinent information for the accomplishment of this task was gained from day to day experience in dealing with the construction. Construction is not a repetitive process in that it is not the same as an assembly line process. Operations change on a day to day basis. In some cases, one can perceive potential problems and correct them before they become a problem but

in most cases a problem will occur and collective action has to be taken to resolve the conflict.

Construction Division does take several steps to improve their effectiveness. The first step is additional training for their employees. The Construction Division has an extensive training program in which project managers and inspectors attend various courses throughout the United States. The general consensus of opinion of those who have attended these classes is that they are worthwhile and additional employees should and are attending them.

During the start of the internship I was told that a lot of information and knowledge was exchanged in the early morning when everyone was getting their cup of coffee. I soon learned that it was true that in the early morning as we were gathered around the layout table, we often discussed various projects and different stages they were in, and corrective action that could be taken. As a result, other people who have had similar experiences were able to share their knowledge.

Another important item worth discussing is the fact that the A&M University System will always be doing construction. They average approximately $50,000,000 worth of construction a year and have gone as high as $80,000,000 and as low as $35,000,000 - $40,000,000

Unlike other engineering firms whose work goes in stages, the Texas A&M system is somewhat stable in the fact that they will always do construction in the neighborhood of $50,000,000. Therefore, management is not greatly concerned with what happens in terms of shortages or in terms of excessive work.

The Consequences

There are several valuable items accomplished and learned during this task of Project Management. First, I was able to assure that the technical requirements of the construction contracts were met. This required close coordination with the Contractor, Contractor's quality control inspector, and fellow inspectors and engineering support personnel. Second, I was responsive to the request by the Contractor and User to make changes or modifications to the project. This required thorough review and negotiations on the issues involved. Third, I was able to share the relevant information and documentation to assist and promptly resolve contractual problems, disputes and/or claims. This required verifying several facts of the situation and maintaining accurate documentation along with an effective filing system for quick retrieval. Fourth, I assured that the contract schedules and contract submittal dates were met. This

required careful review of contract documents, schedules and progress, and was the basis for approving contract or progress payments. Fifth, I prepared and presented managerial summary reports and briefings to area office management people to keep them informed of the project status. Sixth, I gave positive direction to the project. This required planning and anticipating problem areas and resolving those conflicts in those areas. Seventh, and most important, I was able to assist the Construction Division in accomplishing the primary goal of construction inspection and turning over a usable facility to the User.

Contributions To Other Organizations

The major contributions to other organizations during the internship were with other civil engineering and construction science graduate and undergraduate classes. During the entire internship, several times a month, I would accompany classes or students to various construction projects on the campus. It surprises me that the faculty at Texas A&M doesn't use the construction on the campus as a better means to illustrate different aspects of the engineering and educational process. One of the best means of education is actual field experience or field trips. Not only were the field trips pleasurable, they were motivational and educational.

There are many items in the classroom that are only discussed but could be visually reinforced through the use of a field trip to the site. There is no doubt that through this internship I will be able to make a better contribution in the academic area when I return to the Air Force Academy and for the future of the Air Force when I deal with construction projects when I leave the Academy. The internship definitely broadened my experience.

Summary Of Construction Projects

This task started the day I started the internship and will end long after the internship is over. I plan on following what happens to some of the projects after I leave the internship. I did not have nor maintain a daily schedule to work on the various projects. Some days I may have spent a few minutes on the project while another day I may have spent the entire day on the project. It was simply a day-to-day process and urgency that dictated a time based chart of activities.

The construction industry is not like a manufacturing industry or an assembly line where one can work on one process for "X" amount of time during a given day and then move on to another. In the construction industry you may be doing one thing at a point in time and have no idea how long it is going to take to accomplish. The only time I

was able to devote my full time to Project Management was in the absence of George Cole when I assumed his responsibilities for all four construction projects. During the rest of internship I divided my time among different projects, not only the Southside Parking Garage or the ORTC, but other projects that were in the system.

TEMPORARY SITE UTILITIES

Objective - Temporary Site Utilities

The objective of this assignment task was to analyze the benefits of the TAMU System providing temporary site utilities for Contractors or require the Contractor to pay for his own temporary utilities. Currently all projects at Texas A&M University System include a paragraph in the General Specification which requires the General Contractor to pay for temporary utilities. It may be more cost effective to have the Construction Division pay for these site utilities.

Task Description

The current procedures require contractors procure and finance all temporary site utilities. The utilities concerned are telephone, water and electricity. In some cases it could even include chilled water and sewer. For the purpose of this task, telephone was omitted as one of the temporary site utilities since the Telephone Company is responsible for such service. Contractors increase their bid to handle temporary utilities for the construction project. Rather than have the Contractor include this cost in his bid, it may be advantageous for the Texas A&M System to pay for the utilities directly . There are two ways this could be accomplished. One would

be a separate line item when the project is in its the initial stages and the financing aspects of the project are presented to the Board of Regents. In other words, the financing would include a specific line item for site utilities and the utilities would be paid for as they are used during the construction progress from the University System's account to the Physical Plant's account. The money for the site utilities would remain in the system and transferred to the Physical Plant on a monthly basis. A second method is for the System to pay for the utilities. The Construction Division would pay for them directly like they do with materials testing; however, temporary site utilities have not been incorporated into the fee for the Construction Division is currently reimbursed.

In any case, the system will eventually pay for the temporary site utilities. The question is, if the Contractor includes it in his bid, is he including an excessive amount for temporary utilities or is he underestimating the utilities that he will use? If the Contractor over-estimates the utility costs, then in the long run, the system is spending more for temporary utilities than they would if they were paying for the utilities directly. On the other hand, if he under-estimates his utility costs, than the contractor is losing

money and he may attempt to recoup those losses by other means. In addition to the actual financing, there's a considerable amount of paperwork involved with the Physical Plant and all the contractors working on various projects in the system. If the Physical Plant dealt with only one source, either someone in the Finance Department or the Construction Division and the utilities were paid from a single Texas A&M account, it would greatly relieve the Physical Plant's responsibilities for receiving the funds for the different utilities from so many different contractors. Three options are available:

1. Leave the entire process as it is. In other words, the Contractor pays for temporary utilities and thus will increase his bid accordingly.

2. The System develops a separate line item, like they do with furniture or contingency and finance the utilities from a particular line item.

3. Construction Division directly pays for temporary utilities to the Physical Plant. However, Construction Division will have to increase their fees to accommodate this extra cost.

Administration And Managerial Assignments

This particular task has no managerial assignments. The administrative assignments were determining and documenting the best alternative to use in paying for temporary utilities. This involved researching the

administrative procedures currently in effect and seeing what changes would have to be made in the system to incorporate any changes if an alternative plan were used to pay for temporary utilities. I will also discuss the benefits and drawbacks of the three alternatives.

Description Of Non-technical Problems

There are several non-technical problems associated with this task. One is the large number of contractors that are currently working with the system. On the average 40 different contractors are doing construction in the system at any given time . This requires that the Physical Plant set up, maintain and account for all the different temporary utilities that are currently being used. It also makes the Physical Plant responsible to ensure that the contractors pay for the temporary utilities; there have been some problems associated with this in the past. For example, at the Prairie View campus, the electrical usage monitoring equipment failed so the temporary electrical utilities were not monitored correctly. As a result, the Physical Plant at Prairie View had no idea exactly how much electrical use the Contractor utilized. The Physical Plant sent the Contractor an enormous electrical bill which could not be substantiated. The result was several heated discussions

and higher management involvement before the project resumed.

On the other hand, the System paid for the utilities, then the question would have to be raised, "what incentive would the Contractor use to conserve utilities?" These are just a few of the issues surfaced in my analyses of the task.

The Method Or Approach To The Task

The first step was to inquire into the existing method of a contractor paying for temporary utilities. This involved discussion with the various contractors, FP&C and Physical Plant personnel. In addition to reviewing the procedures that are currently in effect, it was also important to talk to contractors on how they determine temporary site utility cost estimates to include in their bids. Once the existing system was researched and understood one could make analytical studies to see if it is more beneficial for the System to pay for the utilities directly or have the Construction Division pay for the utilities. It may be possible to try several new projects under a different system of paying for the temporary site utilities in order to get a better perception of benefits.

Sources Of Information Required To Perform Task

The three main sources of information required to perform the task are:

1. The Contractor.
2. Physical Plant Personnel.
3. Research to see who paid for temporary utilities at other universities and even city municipalities.

The Contractor is the major source of information since he is currently the one who sets up, pays and includes the costs in his bid.

Since Physical Plant personnel collect and are responsible for overall utility usage in the system, they were an important source of information. Since the Physical Plant is a key player in any method concerning utilities, their view point is indispensable.

In my previous experience I have seen both methods of paying for temporary utilities. The Air Force pays for all temporary site utilities directly (except telephone - the contractor pays for this utility), thus the Contractor did not have to worry about procuring and financing temporary utilities. I have also been on other construction projects in which the Contractor was totally responsible for temporary site utilities and had to reimburse the government.

Discussion Of Pertinent Information

Information for this particular task was available but once again it had to be researched and data collected. The decision on who should pay for temporary utilities depends on the aspect of whether the contractor is paying more for utilities than what he included in his bid or whether he is paying less. If the Contractor is paying more for utilities than he has included in his bid, it would be more advantageous for the System to keep the current policy and let a contractor pay for temporary utilities. On the contrary, if most or all contractors are putting more into their estimates and thus their bid, then the system would be better off by having a lower bid and paying for the utilities directly or through the Construction Division.

The Consequences

The major consequence is saving money and manpower for the University System. If the System pays for the utilities directly to the Physical Plant, the Physical Plant;

1) will always know who will pay,

2) will know when they will be paid,

3) will not have to run down the contractor to receive payment.

It was an interesting task from the standpoint that I was able to analyze how a contractor includes temporary utilities in his bid and his procedure for paying for temporary utilities.

After several discussions with various contractors and university personnel, there was general consensus that the University could save money by paying for the utilities directly or through the Construction Division. With that in mind, I began to research cost estimating temporary utilities and the method used by the contractors. Unfortunately, I started this task too late in the internship and soon realized the diversity among contractors in determining their cost estimates for temporary utilities. I soon realized that there were no simple cost estimating procedures and there were several different methods used by the contractors. Some contractors based their estimate on historical data and linked that data to the square footage of the facility under construction. Other contractors simply made an educated guess. If the University were going to pay for these utilities either one of the two decisions are required:

1. The university would pay for the utilities as required and not estimate the cost.

2. A cost model would be prepared using historical data for a reliable cost estimate included in the financial plan.

I did not determine if the university should pay for the utilities directly or through the Construction Division. If the university pays for the utilities through the Construction Division, then the Construction Division fees will have to be readjusted and I did not collect the data required to establish the new fee needed to pay temporary site utilities.

In conclusion, this task requires additional study. At first, I thought a master student's research project would be ideal; however, it may require an experienced consultant or staff summary team to investigate and determine the cost estimating model and best approach to fund these utilities.

Contributions To Outside Organizations

The major contributions to outside organizations are in the possible contributions made to the Physical Plant and the entire System. The purpose of this particular task was to see if money and manpower could be saved.

Summary Of Temporary Site Utilities Task

Like all previous tasks, I did not devote full time to analyzing and accomplishing this particular task. While accomplishing this particular task in a given day I had other activities and tasks to accomplish. As

mentioned above, this task was not completed in its entirety. The task will require additional surveys and discussion with other university personnel. This task did establish the fact that the University paying for temporary site utilities is a viable option and pursued.

SUCCESSFUL CONSTRUCTION MANAGEMENT

Objective - Successful Construction Management

The objective of this assignment task was to research and analyze the cost effectiveness of establishing a Construction Manager (CM) in house or hiring an outside CM consultant for individual project(s).

Task Description

The construction world creates a complex relationship between many different disciplines performing the construction. The existing project delivery system mentioned earlier in the report emanate in working relationships that are frequently being questioned because someone failed to perform in accordance with the contract documents or user requirements. The lack of overall project control is also one of the many concerns owners have seen as construction costs escalate, construction time increases and quality control decreases. The defined need to manage complex activities and responsibilities of recent projects has set a stage for what is now known in the construction industry as a Construction Manager System.

Construction Management is a delivery system available to Owners that provides special management capabilities throughout the project delivery process.

This newly-created discipline of CM provides services necessary to control cost, time, and quality requirements during each phase of the project. This multidiscipline service organization must be well trained in every phase of the project in order to provide meaningful input to the design, contracting, construction and feasibility for occupancy. This task analyzes the current delivery system, and the effectiveness to be gained through hiring a CM or through establishing that function in-house within the Construction Division.

Administration And Managerial Assignments

Since this task involves the researching and discussing of the cost effectiveness of hiring a CM or establishing in house, there are no managerial assignments associated with this particular task. Administratively, there is a considerable amount of work that needs to be accomplished in this particular task. If a CM is to be established in-house, the following seven steps are required:

1. List the duties for which an employee must be responsible.

2. Divide the duties into individual positions.

3. Arrange these positions into integrated functional structures showing lines of supervision.

4. Staff the organization.

5. Establish lines of communication.

6. Receive permission and funding from the Board of Regents.

7. Discuss the plan with everyone concerned.

If a CM firm is hired, there are other administrative issues to considered. The most significant would be determining the compensation for the construction manager, whether it be a percentage of construction cost, a lump sum fee or a professional fee with a guaranteed maximum. Not only must the compensation be determined but what kind of contractual arrangement has to be developed. If a construction management firm is hired then the decision must be made on what to do with the current procedures and personnel employed in the construction division. Depending on the responsibilities of the construction management firm, the Construction Division staff may be reduced or may be increased.

Description Of Non-technical Problems

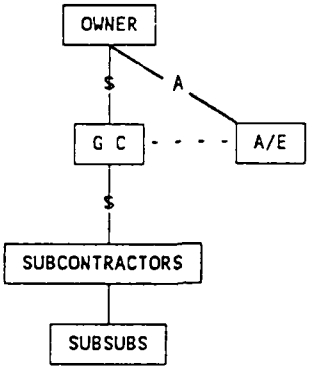
Although numerous delivery systems have been used and developed in the past, the Construction Management delivery system is a fairly new delivery system. The Construction Management delivery system developed simultaneously in several different regions producing different variations and forms (Scott 1990). Unfortunately, it has not gained the popularity it

deserves. The term, Construction Management, is well-known but this delivery system is different in the number of contracts for each project. In this delivery system there are multiple contracts not just a single contract with a general contractor. In addition to multiple contracts, a construction manager is brought at the beginning of the design. This enables the construction manager to be more involved in the initial design phases of the contract. The intent is to help build quality into the design. Although this particular approach to construction has been used in several states, some of the publicity is negative because CM is used on projects that do not adapt themselves to this kind of delivery system. If construction can be done by a prime contractor who does most of the work himself (the contractor utilizes few subcontractors), it may be more advantageous to go with a single general contractor. With the various projects in the Texas A&M System, it may be probable for the Construction Division to continue their current delivery system, hire a construction manager for some projects, and also establish a CM in house to handle other type projects. Some of the problems documented in the past have been forcing a decision on a construction project as to which delivery system would have been better.

Method Or Approach To The Task

The first step in accomplishing this particular task was to gain an understanding of the current delivery system that is used at Texas A&M System. The current delivery system as mentioned above in task 2, and shown in Figure 12 below, is a good delivery system and does work; however, there are and will be construction projects in which a third party construction manager or a CM in house will be more beneficial. In the figures that follow, it should be noted that the Construction Division and the user are displayed as the owner.

The Southside Parking Garage is a prime example where a construction management system should have been used. In a limited sense, Argee, the general contractor, is a construction manager. Argee did not do any of the actual work on the Parking Garage. They subcontracted the entire



Solid Lines - privity of contract by written agreement
Dashed Lines - cooperative relationships established by written agreement
Dollar Sign ($) - independent contractor relationship between parties
Letter (A) - legal agency relationship rather than a independent contractor

FIG. 12. Current Construction System (GC System)

project. In fact, Argee only had three people on his company payroll. There is a contractual requirement for the general contractor to accomplish at least 20% of the work; however, they get around that particular clause in the specification by paying for materials, such as the concrete and steel. There is no doubt, that the effectiveness of using a CM on a parking garage would have been more beneficial for the Texas A&M System than using a general contractor. If a construction manager was brought on board at the same time that the Architect was hired, a majority of the architectural problems would have surfaced earlier in the design phase and could have been corrected before the contract was bid.

The second method of approach was to learn as much as possible about the new construction management technique and its delivery system. In order to establish a CM in house I had to spend some time looking at available personnel in the organization and in seeing what changes had to be made to the organization in order to incorporate the CM function in house.

A final approach method would be a review of different projects that have taken place and some projects that are under consideration to see if the delivery system could be beneficial. If the System did go with the construction manager or a in-house CM, several questions

would have to be answered before using a new delivery system. The questions are:

1. Is it legal for Texas A&M to go out and hire a construction manager the way they do an architect?

2. How should a CM be selected?

3. If CM is done in house, what additional fees will the construction need to handle the additional staffing requirements?

Sources Of Information Required To Perform Task

There are three main sources of information required to perform this particular task. They were:

1. the current Construction Division organization and the current construction delivery system,

2. a literary research to see what companies have done using the new construction management system,

3. the information from a conference called "Successful Construction Management Techniques and Procedures" which was presented at the University of Wisconsin on February 5, 1990.

Even if the Construction Division does not hire a construction manager or establish a CM in house, the conference was very beneficial and meaningful. A majority of the applications and issues discussed can be applied to all delivery systems. There have been numerous journal articles written lately concerning the new delivery system. When I started the internship, I did not realize there are several firms in the United States that

specialize in Construction Management while being employed the same time the architect is hired and dealing with multiple bids.

Discussion Of Pertinent Information

Most of the information for this particular task was available from the conference proceedings and journal articles. Most engineering firms and some architects do CM work; however, they are not engaged exactly the same time an architect is hired nor do they discuss and deal with multiple contracts. The key to this type of delivery system is the fact that there is more than one contract and the construction manager is engaged at the same time the architect is hired. Bringing the CM firm on line at the same time an architect is hired and the use of multiple contracts can be beneficial for a number of reasons:

1. Saves money for the Owner.
2. Construction Management was developed to respond to Owner criticism of construction industries practices.
3. Allows Owners to select managers on ability basis.
4. Allows selectivity of trade contractors.
5. Provides comprehensive competitive bidding.
6. Provides direct payment from Owner to Contractors.

7. Eliminates prebid and postbid shopping.

8. Allows contracting input during preconstruction (constructability).

9. Provides checks and balances to decision making.

10. Provides total project management continuity.

11. Provides the best opportunity for management applications.

12. Allows optimum contractibility opportunities.

13. Assures the lowest contract cost through fair bidding practices.

14. Practically eliminates the conflict of interest factor.

15. Permits controlled/competitive fast tracking.

16. Totally identifies and manages Owner risk.

17. Provides a new level of Owner awareness.

18. Puts a construction expert in the Owner's corner.

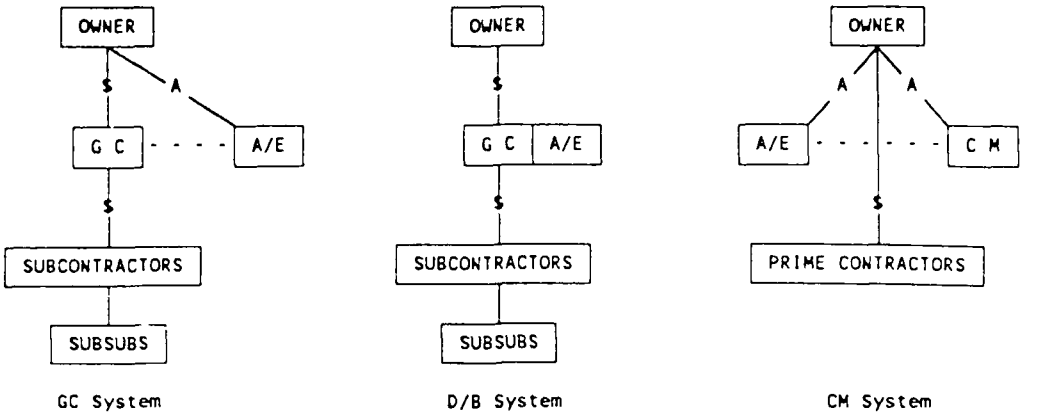
19. Facilitates a constructive use of union and nonunion contractors on the same project.

The substitution of a service-oriented construction manager for profit oriented general contractor is designed to provide Owners with improved quality, time, and cost parameters and generally solve some of the problems recently attributed to the traditional construction industry practices. Pressure from dissatisfied users of current systems prompted the emergence of a new system of contracting, an alternative to the General Contractor

(Haltenhoff 1990). The new system, construction management, emphasizes the management aspects of project delivery rather than assumption of risk by the General Contractor. Initially the CM system and services were very loosely defined, causing many providers and users of CM services to become involved in contractual situations neither fully understood nor appreciated. CM survived its uncertain years and has essentially achieved universal acceptance. Several standard contract documents are available for CM use and an association was formed to look after CM interest. In addition, standards of practice have been formulated and consideration is being given to a program for certifying CM practitioners. Currently, work is underway to certify CM professionals (Scott 1990).

Contracting Systems

There are three basic contracting systems (Haltenhoff 1990). The first is the GC system, second is design build system and third is the ACM form for the CM system (see Figure 13 on the next page)



Solid Lines - privity of contract by written agreement
Dashed Lines - cooperative relationships established by written agreement
Dollar Sign ($) - independent contractor relationship between parties
Letter (A) - legal agency relationship rather than a independent contractor

FIG. 13. The Three Basic Contracting Systems

The Agency CM (ACM) form is the root form of the CM system. The major advantage of ACM is the agency relationship between the CM and the Owner. The CM is an agent of the Owner and executes the project overtly, and within the legal context of agency. On the other hand, the General Contractor and Design/build Contractors approach the project delivery process as entrepreneurs (Haltenhoff 1990). There are three distinctly different subforms regenerated by changing the responsibilities of the ACM team members.

1. The Extended Services CM,
2. Guaranteed Maximum Price
3. The Owner CM.

Other variations of these three subforms are created by changing responsibilities of the team members.

The extended services XCM subform has four variations (see Figure 14.)

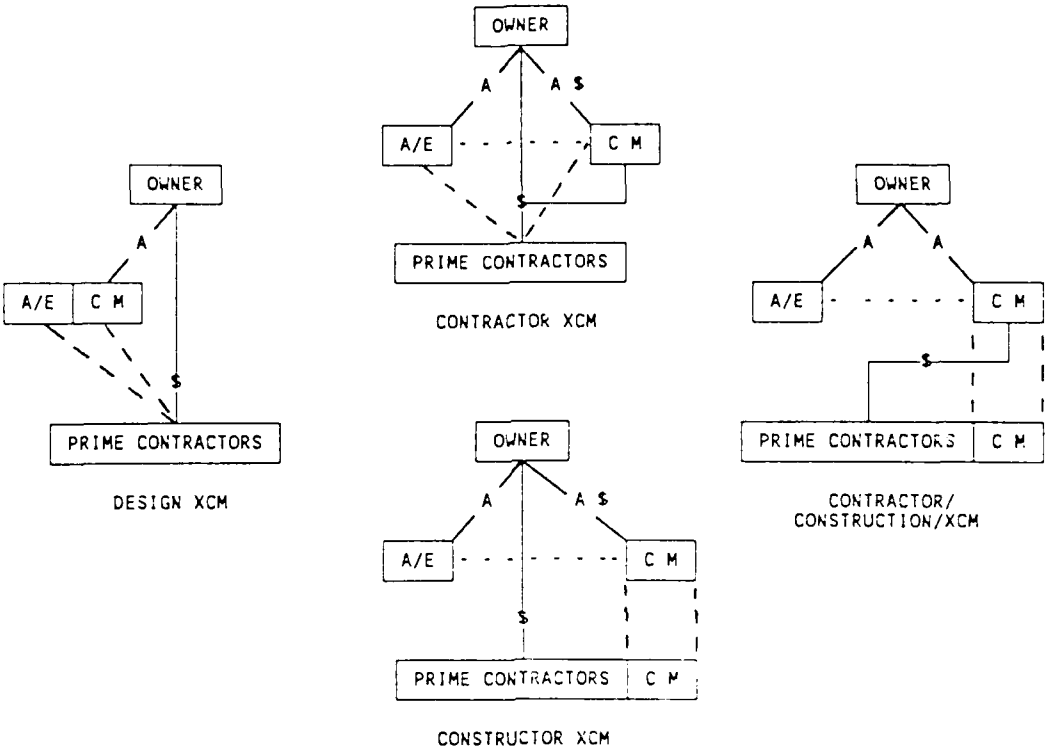


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FIG. 14. The Four Extended Services CM Variations

The first variation, Design XCM, combines the design services and the CM services. This form of CM could not be used in-house because the Construction and Planning Division does not have the staffing to do combined A/E and CM work. It is a viable option if Construction Division were to contract out such services. Similarly, the

Construction Division does not have the available resources for the remaining three variations. The Construction XCM and Contractor XCM can only be provided by CM organizations that have the capability to construct with their own forces or the capacity to enter into contracts for the construction. The ultimate extended service subform combines the Contractor XCM and the Construction XCM responsibilities.

Another subform of CM appears to be the variation of ACM with a guaranteed maximum price (GMP). There are three subforms (Haltenhoff 1990) of CM for a guaranteed maximum price (see Figure 15.)

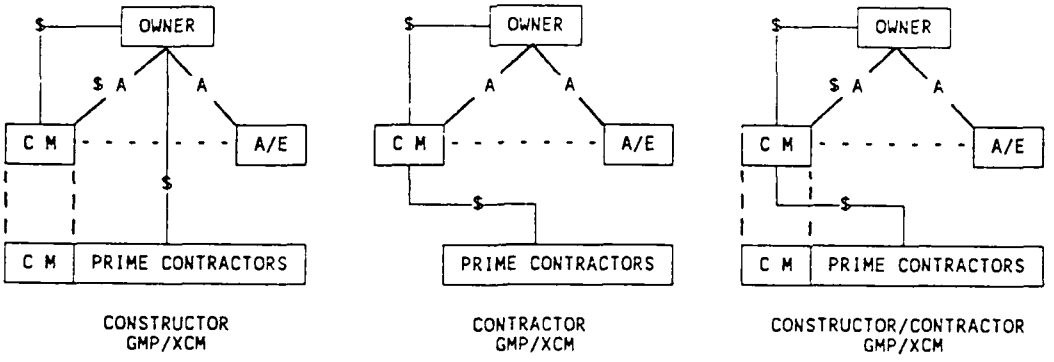

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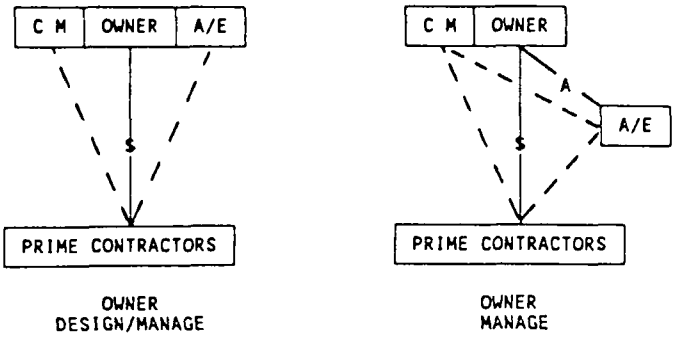
FIG. 15. The Three GMPCM Variations

The three GMPCM combinations are similar to other variations except the fact that the CM provides a

guaranteed maximum price to the Owner for the total cost of the project when the design is approximately 80% complete. GMP converts the agency arrangement to an independent contractor arrangement, even though the CM's ACM responsibilities continue. Although it would be nice to have a guaranteed maximum price before construction begins, it would be difficult to arrange in-house or even contract out such services. To use GMP in-house, would require an extensive cost estimating department and then there's the risk of under-estimating the actual price causing additional problems. If an owner were to contract the project with a GMPCM, the delivery system is same arrangement as the Southside Parking Garage project. On that project, the Contractor, Argee, is actually a CM that has bid a single price. Argee, in turn, subcontracted the project to various subcontractors. This arrangement is similar to guaranteed maximum price. The particular arrangement is not much different from a general contracting arrangement except, that in this case, the General Contractor does other CM type services, like scheduling the work of his subcontractors.

Since the CM system was originally Owner inspired, owner subforms are assumed to be the oldest CM subform in the system. There are two major variations (Haltenhoff 1990) of Owner form of CM (see Figure 16.) The first is a



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Letter (A) - legal agency relationship rather than a independent contractor

FIG. 16. The Two Owner Variations

Owner design/manage variation in which the CM, the Owner and the A/E are all one, dealing with various prime Contractors. This variation could not be used in-house since the Construction Division and the Planning Division are not staffed to do CM and A/E work in house of this magnitude. The second variation is where the CM and the Owner are one and hire an independent A/E. If the Construction Division were to do any CM services in house it would be similar to this arrangement.

The variations of CM can easily be confused with either General Contractor or the Design Build System; however, close evaluation of the diagrams shows that the CM is in an agent role and it is that agent role that survives in each of these cases. The Owner expects different performance from an agent than from an independent contractor.

Project Cost Feature

One major feature that distinguishes between the CM system and General Contractor and Design Build Systems is project cost. In cost reimbursable contracts, subcontracts, materials, equipment, etc., are unilaterally determined, priced, totalled, and presented to the Owner by the Contractor. Owners are not part of the proposal process or the general selection process of subcontractors/suppliers. With a CM system, regardless which variation is used, project needs are established using the team concept. The project is selectively divided into many independent work scopes, each bid individually by trade contractors in direct competition.

Preserving the Owner Orientation

The CM system is designed and was designed to be Owner oriented. The ACM contractual arrangements are designed to accrue benefits to the Owner. Benefits have not always accrued from the General Contractors or Design Build Contracting Systems. There are two very important Owner oriented conditions that are used in the agency structure. They are:

1. the period of relationship between the Owner, the A/E and the CM which allows for a team approach to all designs.

2. the segregation of the required design and construction management services facilitates checks and balances and precludes conflicts.

Checks and Balances

Since it is assumed that each team member, the Owner, the A/E and CM have unique abilities in their particular expertise, they will be able to contribute to the others' performance based on their individual industry experience. Using a team effort and continuing in this effort through other projects results in value management. The CM system can learn and improve as it is doing more and more projects. The CM system is highly dependent on collective results of individual performances unlike all the individual authority in a general contracting superintendent. These individual performances also help reduce potential conflicts of interest. When responsibilities are combined, such as in General Contractor or Design Build system, there is an increased potential for conflicts of interest. There is no doubt that the ACM form establishes an ideal relationship to make the CM process theoretically as functional as possible.

The CM Organization

As mentioned earlier, there are two methods of incorporating ACM into the Texas A&M System. The first method assumes hiring a CM firm. There are several firms in the country which specialize in such service. I do not believe the Texas A&M System would have difficulty in

procuring such services.

The second method concerns establishing a CM function in house. The Construction Division already has in place the five basic departmental areas that a CM firm should have.

1. Management - leadership and policies.

2. Administration - office services, accounting and payroll.

3. Operations - format execution.

4. Resources - value management, financial and management control.

5. Support - communications, transportation, typing and clerical.

The core of the CM organization is in the operations and resource departments. Operations needs a Control CM individual and a Field CM individual. The purpose of a Control CM is to provide the management function on one or more CM projects through the utilization of the organizational resources and the outside representation of a Field CM. The purpose of a Field CM is to provide the coordinating function in the field on a specific CM project under the direction of the Control CM. Essentially, the Field CM position serves as the eyes, ears and voice of the team members on the project site. In addition to a Control CM and a Field CM there is and should be a CM Coordinator whose purpose is to provide support and back up for the Control CM. The Control CM is

a training position which would eventually train the individual for the position of a Control CM.

Under the Resource Division there are additional personnel required. One would be a Financial and Management Control Manager (FMCM) who would supervise the scheduling, reporting and computer operations. The purpose of a FMCM is to coordinate and administer the financial and management control systems inherent in the CM project delivery system. Another position in the Resource Division is a Value Manager (VM). The purpose of this position is to provide timely cost information and alternative methods of approach to proposed design concepts, with the intention of controlling the economic factors of CM projects.

In addition to a VM and a FMCM, A CM organization may require civil, electrical, mechanical and architectural engineers. These engineers are normally grouped with the in-house A/E team. However, in both the existing Construction Division and Planning Division there are civil, electrical, mechanical and architectural engineers.

Except for the Field and Control CM personnel, the Construction Division has the necessary staff to assume the CM function in house. Effective at the end of October 1990, the Construction Division was reorganized and if additional staff were hired, there would be no problem

with manpower. The additional staff positions require funding which could be achieved by an increased fee. The increased fee would have to be determined and presented to the Board of Regents for approval.

Summary

The Construction Management project delivery system is unique and philosophically different from contemporary systems, i.e. the Design Build or the General Contracting System. The main contractual relationship for the construction of a project in the CM system is agency oriented. The Design Build or General Contractor Systems are totally oriented to an independent contractor relationship. The ACM form affords the least opportunity for potential conflicts of interest, and provides maximum opportunity for checks and balances. Variations of the ACM system exist because of different contract configurations for owners with unique project requirements. As mentioned earlier, there are numerous advantages to a CM delvery system; however, it should be noted that there are numerous disadvantages not listed in this report which must be considered. It would be up to Texas A&M to determine which variation would best suit its needs and the mode of operation may vary depending on the projects they are considering.

The Consequences

Owners, as well as Texas A&M System, have generally expressed discontent with traditional methods of project delivery, citing undependable construction schedules and budget forecasts as well as poor construction quality. These problems indicate that the management of the general contractor is not functioning in the most efficient manner. In addition to getting better work and more work for the dollar, the use of a CM may enable the current project managers and inspectors to do the job they should be doing but do not have the time at the present. Management has low priority in the traditional competitively bid system of contractor selection. Therefore, management input to the construction process is not guaranteed when a contract is awarded. The separation of the design and construction segments of a project cause prime management responsibilities to shift abruptly from the design professional to the general contractor after construction contracts are awarded. There will frequently be an adversarial relationship between the General Contractor and the A/E or Owner. Trade Contractors have stressed their dissatisfaction with many common practices in the General Contractor delivery system such as bid shopping and progress pay distribution. They would also like better quality control by the General Contractor to

avoid reworking the job. It is these problems mentioned above and the advantages of using the CM that TAMUS should consider using a CM on several of their jobs in the future. This would eliminate a lot of the problems which have been encountered in previous construction on the campus. Hiring a CM firm or doing CM work in-house will alleviate the problems mentioned above and provide better facilities for the money.

Contributions To Any Outside Areas

The major contribution will be for future users and owners of construction on the TAMU system. In addition to university construction, using a CM firm may provide the opportunity for more CM type construction in Texas. There is no doubt in reading all the literature on CM that if CM is used properly, it is a viable project delivery system that can be used on many projects. In addition to actual construction benefits, the use of the CM firm, either by hiring or in house, could be a very valuable academic resource. Construction on the campus is the most under-utilized academic resource in the University. Granted, the construction personnel do not have the time to do all the escorting and setting up of field trips that would be required; however, I think it would be good for the Civil Engineering Department to become more involved with the

Construction Division.

Summary Of Successful Construction Management

The majority of this particular task was in the literary research involved. Like the other tasks mentioned above there was no set time chart of activities that could be plotted for this particular task. The goal of this task was to research CM to see if it could be incorporated into future projects at Texas A&M. There is no doubt that this type of delivery system could be used on some of the projects in the future. There are no set guidelines on which projects CM could or could not be used. Nevertheless, the CM system is a viable option for some Texas A&M construction projects and should be pursued.

INTERNSHIP CONCLUSION

The internship has satisfactorily achieved its primary goals:

> "1) To enable the student to demonstrate and enhance his abilities to apply both knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization in which the internship is served.
>
> 2) To enable the student to function in a non-academic environment in a position in which he will learn the employer's approach to problems, in addition to those approaches of traditional engineering design or analysis." (Texas A&M University Doctor of Engineering Program Manual)

The specific and general objectives outlined at the beginning of the internship provided the basis for accomplishing the primary goals.

The forecasting model was completed and implemented. The predicted or estimated FY90 construction total was $42,062,000 and the actual earned value was $43,875,000. The estimated amount was only 4.1% under estimated, well within 5%. Individual projects varied, depending on the time of year and the contractor but the overall computer program is worthwhile and useable.

The cost accounting system has been implemented for three months and used by several members of the organization. Besides employee accounting information, the program is used by management to view expenses on individual projects.

The experience gained from performing project manager and inspector duties was invaluable. This task was the most enjoyable yet very demanding. Not only did I gain insight into new construction management ideas, but I was able to make identifiable contributions to the organization.

Additional studies and approval are required to change the procedures concerning temporary site utilities. During this internship I discovered that the University could save money by paying for the utilities directly or through the Construction Division.

Hiring a CM or establishing a CM in house provides an excellent opportunity for Texas A&M to receive better construction quality and more for their money. The system needs to pursue this task and try this approach on several future projects.

In reviewing this past year, I ask the questions

1. Was the internship rewarding and a climaxing experience to the course work?

2. Would I recommend this program to other graduate students thinking about entering the Doctor of Engineering program at Texas A&M?

The internship with the Facilities Planning & Construction Department was second to none and I would not hesitate in recommending the program to anyone. The only drawback I encountered was the lack of knowledge that professional and academic societies garner concerning the

Doctor of Engineering Program. It is an excellent program only known to few individuals.

The internship and my Texas A&M experience will always be pleasantly remembered.

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APPENDIXES

APPENDIX I. Data Points - Project <$3 Million

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
0.0000	0.0000	0.1667	0.4781	0.3333	0.5719	0.5000	0.7310
0.6667	0.8478	0.8333	0.9615	1.0000	1.0000	0.0000	0.0000
0.1111	0.0833	0.2222	0.1373	0.3333	0.2310	0.4444	0.3500
0.5556	0.6628	0.6667	0.8443	0.7778	0.9440	0.8889	0.9908
1.0000	1.0000	0.0000	0.0000	0.0556	0.0000	0.1111	0.1091
0.1667	0.1898	0.2222	0.2420	0.2778	0.2929	0.3333	0.3257
0.3889	0.3794	0.4444	0.4540	0.5000	0.5417	0.5556	0.5659
0.6111	0.5933	0.6667	0.6402	0.7222	0.7108	0.7778	0.7814
0.8333	0.8437	0.8889	0.9123	0.9444	0.9703	1.0000	1.0000
0.0000	0.0000	0.0909	0.0856	0.1818	0.1885	0.2727	0.2596
0.3636	0.4239	0.4545	0.5604	0.5455	0.7232	0.6364	0.8061
0.7273	0.8350	0.8182	0.8981	0.9091	0.9695	1.0000	1.0000
0.0000	0.0000	0.1111	0.0180	0.2222	0.1073	0.3333	0.2769
0.4444	0.4126	0.5556	0.6057	0.6667	0.7880	0.7778	0.9002
0.8889	0.9923	1.0000	1.0000	0.0000	0.0000	0.0769	0.0653
0.1538	0.1173	0.2308	0.1450	0.3077	0.1701	0.3846	0.2111
0.4615	0.2639	0.5385	0.4423	0.6154	0.5787	0.6923	0.7154
0.7692	0.8493	0.8462	0.9281	0.9231	0.9856	1.0000	1.0000
0.0000	0.0000	0.1429	0.1316	0.2857	0.3160	0.4286	0.5484
0.5714	0.6900	0.7143	0.8073	0.8571	0.9844	1.0000	1.0000
0.0000	0.0000	0.0769	0.0000	0.1538	0.1545	0.2308	0.2143
0.3077	0.3175	0.3846	0.4608	0.4615	0.6577	0.5385	0.7811
0.6154	0.8650	0.6923	0.9199	0.7692	0.9329	0.8462	0.9396
0.9231	0.9823	1.0000	1.0000	0.0000	0.0000	0.1111	0.0490
0.2222	0.0658	0.3333	0.2042	0.4444	0.3426	0.5556	0.4692
0.6667	0.6873	0.7778	0.8992	0.8889	0.9657	1.0000	1.0000
0.0000	0.0000	0.1111	0.0455	0.2222	0.1319	0.3333	0.1856
0.4444	0.2930	0.5556	0.4119	0.6667	0.5795	0.7778	0.7958
0.8889	0.8983	1.0000	1.0000	0.0000	0.0000	0.1000	0.0640
0.2000	0.1758	0.3000	0.3237	0.4000	0.4946	0.5000	0.5805
0.6000	0.6665	0.7000	0.8054	0.8000	0.8975	0.9000	0.9883
1.0000	1.0000	0.0000	0.0000	0.0667	0.0000	0.1333	0.1249
0.2000	0.2112	0.2667	0.2818	0.3333	0.3563	0.4000	0.4456
0.4667	0.5331	0.5333	0.6854	0.6000	0.7418	0.6667	0.7890
0.7333	0.8438	0.8000	0.9065	0.8667	0.9415	0.9333	0.9736
1.0000	1.0000	0.0000	0.0000	0.2500	0.2576	0.5000	0.4876
0.7500	1.0000	1.0000	1.0000	0.0000	0.0000	0.1667	0.1128
0.3333	0.2164	0.5000	0.7170	0.6667	0.8378	0.8333	1.0000
1.0000	1.0000	0.0000	0.0000	0.0625	0.0000	0.1250	0.0748
0.1875	0.1315	0.2500	0.1968	0.3125	0.2494	0.3750	0.2949
0.4375	0.3457	0.5000	0.5231	0.5625	0.6485	0.6250	0.6965
0.6875	0.7649	0.7500	0.8434	0.8125	0.9208	0.8750	0.9681
0.9375	1.0000	1.0000	1.0000	0.0000	0.0000	0.1429	0.1250
0.2857	0.3474	0.4286	0.4728	0.5714	0.6915	0.7143	0.8229
0.8571	0.9474	1.0000	1.0000	0.0000	0.0000	0.1250	0.1187
0.2500	0.2191	0.3750	0.3662	0.5000	0.5013	0.6250	0.7211
0.7500	0.9663	0.8750	0.9887	1.0000	1.0000	0.0000	0.0000

APPENDIX I. (CONTINUED)

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
0.1111	0.1202	0.2222	0.2995	0.3333	0.4406	0.4444	0.6244
0.5556	0.7521	0.6667	0.8947	0.7778	0.9479	0.8889	0.9909
1.0000	1.0000	0.0000	0.0000	0.0667	0.0471	0.1333	0.1171
0.2000	0.1945	0.2667	0.3041	0.3333	0.3889	0.4000	0.4567
0.4667	0.5443	0.5333	0.6443	0.6000	0.7194	0.6667	0.7938
0.7333	0.8361	0.8000	0.8800	0.8667	0.9270	0.9333	0.9808
1.0000	1.0000	0.0000	0.0000	0.2500	0.3062	0.5000	0.5884
0.7500	0.8646	1.0000	1.0000	0.0000	0.0000	0.1250	0.0883
0.2500	0.1555	0.3750	0.3898	0.5000	0.5764	0.6250	0.7149
0.7500	0.8368	0.8750	0.9341	1.0000	1.0000	0.0000	0.0000
0.1111	0.0175	0.2222	0.0871	0.3333	0.2099	0.4444	0.2627
0.5556	0.4761	0.6667	0.5906	0.7778	0.8179	0.8889	0.9539
1.0000	1.0000	0.0000	0.0000	0.0714	0.0629	0.1429	0.1647
0.2143	0.2854	0.2857	0.3580	0.3571	0.5076	0.4286	0.6096
0.5000	0.6910	0.5714	0.7331	0.6429	0.8064	0.7143	0.8778
0.7857	0.9246	0.8571	0.9779	0.9286	0.9931	1.0000	1.0000
0.0000	0.0000	0.1111	0.0698	0.2222	0.2009	0.3333	0.3452
0.4444	0.5864	0.5556	0.7421	0.6667	0.8408	0.7778	0.9330
0.8889	0.9834	1.0000	1.0000	0.0000	0.0000	0.0909	0.1566
0.1818	0.2647	0.2727	0.3729	0.3636	0.4949	0.4545	0.5699
0.5455	0.6924	0.6364	0.8363	0.7273	0.9017	0.8182	0.9408
0.9091	0.9669	1.0000	1.0000	0.0000	0.0000	0.1250	0.2875
0.2500	0.5594	0.3750	0.7612	0.5000	0.8180	0.6250	0.8724
0.7500	0.9331	0.8750	0.9718	1.0000	1.0000	0.0000	0.0000
0.2000	0.3536	0.4000	0.6348	0.6000	0.8331	0.8000	0.9583
1.0000	1.0000	0.0000	0.0000	0.0833	0.0505	0.1667	0.2060
0.2500	0.3188	0.3333	0.4720	0.4167	0.5588	0.5000	0.7174
0.5833	0.7980	0.6667	0.8889	0.7500	0.9331	0.8333	0.9516
0.9167	0.9964	1.0000	1.0000	0.0000	0.0000	0.1250	0.0000
0.2500	0.0827	0.3750	0.2145	0.5000	0.2823	0.6250	0.7749
0.7500	0.9668	0.8750	1.0000	1.0000	1.0000	0.0000	0.0000
0.1250	0.0927	0.2500	0.2071	0.3750	0.3695	0.5000	0.5395
0.6250	0.7337	0.7500	0.8479	0.8750	0.9349	1.0000	1.0000
0.0000	0.0000	0.1111	0.1131	0.2222	0.2303	0.3333	0.3583
0.4444	0.4861	0.5556	0.6328	0.6667	0.8032	0.7778	0.9441
0.8889	0.9950	1.0000	1.0000	0.0000	0.0000	0.1429	0.0000
0.2857	0.2569	0.4286	0.4005	0.5714	0.6095	0.7143	0.7578
0.8571	0.9629	1.0000	1.0000	0.0000	0.0000	0.0769	0.0397
0.1538	0.0918	0.2308	0.2631	0.3077	0.3648	0.3846	0.4487
0.4615	0.5260	0.5385	0.6073	0.6154	0.7322	0.6923	0.8512
0.7692	0.9188	0.8462	0.9880	0.9231	0.9880	1.0000	1.0000
0.0000	0.0000	0.2500	0.1762	0.5000	0.5290	0.7500	0.8352
1.0000	1.0000	0.0000	0.0000	0.2000	0.2974	0.4000	0.4591
0.6000	0.6742	0.8000	0.8921	1.0000	1.0000	0.0000	0.0000
0.0769	0.0222	0.1538	0.0443	0.2308	0.1265	0.3077	0.2379
0.3846	0.3372	0.4615	0.4361	0.5385	0.5381	0.6154	0.6218
0.6923	0.7692	0.7692	0.9496	0.8462	0.9496	0.9231	1.0000

APPENDIX I. (CONTINUED)

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
1.0000	1.0000	0.0000	0.0000	0.0833	0.0571	0.1667	0.1386
0.2500	0.2302	0.3333	0.3169	0.4167	0.5022	0.5000	0.7430
0.5833	0.7430	0.6667	0.9218	0.7500	0.9218	0.8333	0.9701
0.9167	0.9917	1.0000	1.0000	0.0000	0.0000	0.1000	0.0528
0.2000	0.0896	0.3000	0.2246	0.4000	0.3632	0.5000	0.5327
0.6000	0.6811	0.7000	0.7900	0.8000	0.9538	0.9000	0.9538
1.0000	1.0000	0.0000	0.0000	0.1667	0.0385	0.3333	0.1244
0.5000	0.6795	0.6667	0.9050	0.8333	0.9790	1.0000	1.0000
0.0000	0.0000	0.0909	0.0000	0.1818	0.1449	0.2727	0.1769
0.3636	0.2314	0.4545	0.4744	0.5455	0.4744	0.6364	0.5485
0.7273	0.6946	0.8182	0.8408	0.9091	0.9488	1.0000	.0000

APPENDIX II. Data Points - Project $3 - $7M

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
0.0000	0.0000	0.0667	0.0424	0.1333	0.1091	0.2000	0.2644
0.2667	0.3643	0.3333	0.4823	0.4000	0.5358	0.4667	0.6140
0.5333	0.6668	0.6000	0.7608	0.6667	0.8254	0.7333	0.8377
0.8000	0.8950	0.8667	0.9462	0.9333	0.9841	1.0000	1.0000
0.0000	0.0000	0.0556	0.0752	0.1111	0.1418	0.1667	0.2093
0.2222	0.2768	0.2778	0.3426	0.3333	0.4409	0.3889	0.4892
0.4444	0.5611	0.5000	0.6411	0.5556	0.6732	0.6111	0.7387
0.6667	0.7825	0.7222	0.8251	0.7778	0.8940	0.8333	0.9407
0.8889	0.9772	0.9444	0.9944	1.0000	1.0000	0.0000	0.0000
0.0714	0.0000	0.1429	0.0626	0.2143	0.1026	0.2857	0.1838
0.3571	0.2870	0.4286	0.4001	0.5000	0.5816	0.5714	0.6932
0.6429	0.8515	0.7143	0.9266	0.7857	0.9473	0.8571	0.9806
0.9286	0.9864	1.0000	1.0000	0.0000	0.0000	0.0625	0.0000
0.1250	0.0465	0.1875	0.0942	0.2500	0.1211	0.3125	0.2199
0.3750	0.2849	0.4375	0.3633	0.5000	0.4892	0.5625	0.5785
0.6250	0.6480	0.6875	0.7826	0.7500	0.8354	0.8125	0.8814
0.8750	0.9618	0.9375	0.9885	1.0000	1.0000	0.0000	0.0000
0.1000	0.0000	0.2000	0.0334	0.3000	0.0995	0.4000	0.2027
0.5000	0.3392	0.6000	0.4733	0.7000	0.8206	0.8000	0.9517
0.9000	0.9826	1.0000	1.0000	0.0000	0.0000	0.0476	0.0000
0.0952	0.0226	0.1429	0.0523	0.1905	0.0792	0.2381	0.1102
0.2857	0.1573	0.3333	0.2091	0.3810	0.2851	0.4286	0.3211
0.4762	0.4226	0.5238	0.4815	0.5714	0.5823	0.6190	0.6779
0.6667	0.7097	0.7143	0.7482	0.7619	0.8118	0.8095	0.8791
0.8571	0.9227	0.9048	0.9655	0.9524	0.9901	1.0000	1.0000
0.0000	0.0000	0.0625	0.0321	0.1250	0.0890	0.1875	0.1424
0.2500	0.1920	0.3125	0.3878	0.3750	0.4931	0.4375	0.6319
0.5000	0.6977	0.5625	0.7346	0.6250	0.7988	0.6875	0.8444
0.7500	0.9079	0.8125	0.9449	0.8750	0.9768	0.9375	0.9826
1.0000	1.0000	0.0000	0.0000	0.0714	0.0000	0.1429	0.0206
0.2143	0.0293	0.2857	0.1262	0.3571	0.2388	0.4286	0.3517
0.5000	0.4384	0.5714	0.5565	0.6429	0.6319	0.7143	0.7440
0.7857	0.8303	0.8571	0.9088	0.9286	0.9821	1.0000	1.0000
0.0000	0.0000	0.0588	0.0000	0.1176	0.0423	0.1765	0.0823
0.2353	0.1366	0.2941	0.1698	0.3529	0.2377	0.4118	0.3335
0.4706	0.4838	0.5294	0.5821	0.5882	0.6622	0.6471	0.7343
0.7059	0.7923	0.7647	0.8325	0.8235	0.8799	0.8824	0.9243
0.9412	0.9761	1.0000	1.0000	0.0000	0.0000	0.0714	0.0355
0.1429	0.1196	0.2143	0.1645	0.2857	0.4411	0.3571	0.5118
0.4286	0.5816	0.5000	0.6378	0.5714	0.6811	0.6429	0.7144
0.7143	0.7955	0.7857	0.8827	0.8571	0.9712	0.9286	0.9927
1.0000	1.0000	0.0000	0.0000	0.0833	0.0663	0.1667	0.1614
0.2500	0.2070	0.3333	0.2782	0.4167	0.4194	0.5000	0.5277
0.5833	0.6214	0.6667	0.7195	0.7500	0.8474	0.8333	0.9594
0.9167	1.0000	1.0000	1.0000	0.0000	0.0000	0.0625	0.0332
0.1250	0.0626	0.1875	0.1347	0.2500	0.2130	0.3125	0.2922
0.3750	0.4055	0.4375	0.5201	0.5000	0.6188	0.5625	0.7352

APPENDIX II. (CONTINUED)

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
0.6250	0.8127	0.6875	0.8656	0.7500	0.9272	0.8125	0.9595
0.8750	0.9696	0.9375	0.9915	1.0000	1.0000	0.0000	0.0000
0.0667	0.0294	0.1333	0.0477	0.2000	0.1492	0.2667	0.2483
0.3333	0.3792	0.4000	0.5447	0.4667	0.7360	0.5333	0.8076
0.6000	0.8416	0.6667	0.8801	0.7333	0.9241	0.8000	0.9566
0.8667	0.9821	0.9333	0.9931	1.0000	1.0000	0.0000	0.0000
0.0769	0.0116	0.1538	0.1022	0.2308	0.1624	0.3077	0.2564
0.3846	0.3629	0.4615	0.4743	0.5385	0.5633	0.6154	0.6474
0.6923	0.7249	0.7692	0.7953	0.8462	0.8600	0.9231	0.9203
1.0000	1.0000	0.0000	0.0000	0.0714	0.0000	0.1429	0.0740
0.2143	0.1662	0.2857	0.2585	0.3571	0.3402	0.4286	0.4093
0.5000	0.4814	0.5714	0.5823	0.6429	0.6250	0.7143	0.7181
0.7857	0.8450	0.8571	0.9190	0.9286	0.9749	1.0000	1.0000
0.0000	0.0000	0.0714	0.0000	0.1429	0.0959	0.2143	0.1655
0.2857	0.2314	0.3571	0.3009	0.4286	0.3707	0.5000	0.4405
0.5714	0.5102	0.6429	0.6438	0.7143	0.7377	0.7857	0.8222
0.8571	0.9600	0.9286	0.9600	1.0000	1.0000	0.0000	0.0000
0.0833	0.0335	0.1667	0.1548	0.2500	0.2695	0.3333	0.4037
0.4167	0.4717	0.5000	0.5958	0.5833	0.7670	0.6667	0.7670
0.7500	0.8758	0.8333	0.8758	0.9167	0.9919	1.0000	1.0000
0.0000	0.0000	0.0909	0.0672	0.1818	0.1135	0.2727	0.2031
0.3636	0.2965	0.4545	0.3848	0.5455	0.6976	0.6364	0.6976
0.7273	0.9231	0.8182	0.9231	0.9091	0.9805	1.0000	1.0000

APPENDIX III. Data Points - Project >$7 Million

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
0.4545	0.4314	0.5000	0.4803	0.5455	0.5627	0.5909	0.6591
0.6364	0.7418	0.6818	0.7996	0.7273	0.8289	0.7727	0.8552
0.8182	0.8736	0.8636	0.8976	0.9091	0.9310	0.9545	0.9688
1.0000	1.0000	0.2727	0.1043	0.3182	0.1434	0.3636	0.1699
0.4091	0.2180	0.4545	0.2654	0.5000	0.3030	0.5455	0.3468
0.5909	0.4284	0.6364	0.5199	0.6818	0.5761	0.7273	0.6790
0.7727	0.7537	0.8182	0.8107	0.8636	0.8440	0.9091	0.9004
0.9545	0.9680	1.0000	1.0000	0.0000	0.0000	0.0526	0.0000
0.1053	0.0000	0.1579	0.0571	0.2105	0.0708	0.2632	0.0955
0.3158	0.1452	0.3684	0.2039	0.4211	0.2545	0.4737	0.3236
0.5263	0.4196	0.5789	0.5011	0.6316	0.5994	0.6842	0.6797
0.7368	0.7511	0.7895	0.8043	0.8421	0.8739	0.8947	0.9247
0.9474	0.9665	1.0000	1.0000	0.0000	0.0000	0.0476	0.0137
0.0952	0.0588	0.1429	0.1128	0.1905	0.2164	0.2381	0.2707
0.2857	0.3324	0.3333	0.3944	0.3810	0.4544	0.4286	0.5430
0.4762	0.6148	0.5238	0.6869	0.5714	0.7206	0.6190	0.7603
0.6667	0.8200	0.7143	0.8600	0.7619	0.8996	0.8095	0.9299
0.8571	0.9601	0.9048	0.9747	0.9524	0.9863	1.0000	1.0000
0.0000	0.0000	0.0455	0.0248	0.0909	0.0373	0.1364	0.0635
0.1818	0.0999	0.2273	0.1278	0.2727	0.1531	0.3182	0.2338
0.3636	0.2898	0.4091	0.3505	0.4545	0.4191	0.5000	0.5072
0.5455	0.6008	0.5909	0.6830	0.6364	0.7386	0.6818	0.7689
0.7273	0.8152	0.7727	0.8665	0.8182	0.9040	0.8636	0.9517
0.9091	0.9806	0.9545	0.9952	1.0000	1.0000	0.0000	0.0000
0.0500	0.0000	0.1000	0.0582	0.1500	0.0837	0.2000	0.1170
0.2500	0.1533	0.3000	0.1932	0.3500	0.2449	0.4000	0.3128
0.4500	0.3846	0.5000	0.4564	0.5500	0.5309	0.6000	0.6046
0.8500	0.9484	0.9000	0.9760	0.9500	0.9916	1.0000	1.0000
0.0000	0.0000	0.0435	0.0255	0.0870	0.0928	0.1304	0.1379
0.1739	0.1467	0.2174	0.1822	0.2609	0.2240	0.3043	0.2815
0.3478	0.3322	0.3913	0.3886	0.4348	0.4928	0.4783	0.5525
0.5217	0.6468	0.5652	0.6960	0.6087	0.7625	0.6522	0.8061
0.6957	0.8312	0.7391	0.8588	0.7826	0.8968	0.8261	0.9680
0.8696	0.9680	0.9130	0.9829	0.9565	0.9946	1.0000	1.0000
0.0000	0.0000	0.0588	0.0000	0.1176	0.0000	0.1765	0.0000
0.2353	0.0840	0.2941	0.2088	0.3529	0.2653	0.4118	0.3418
0.4706	0.4298	0.5294	0.5561	0.5882	0.6332	0.6471	0.6766
0.7059	0.7406	0.7647	0.8057	0.8235	0.8771	0.8824	0.9853
0.9412	0.9853	1.0000	1.0000	0.0000	0.0000	0.0833	0.0537
0.1667	0.1160	0.2500	0.2226	0.3333	0.3317	0.4167	0.4648
0.5000	0.5671	0.5833	0.6693	0.6667	0.7521	0.7500	0.8275
0.8333	0.9039	0.9167	0.9946	1.0000	1.0000	0.0000	0.0000
0.0769	0.0000	0.1538	0.1142	0.2308	0.2166	0.3077	0.3765
0.3846	0.4869	0.4615	0.6066	0.5385	0.6940	0.6154	0.7870
0.6923	0.8647	0.7692	0.9280	0.8462	0.9940	0.9231	0.9940
1.0000	1.0000	0.4545	0.4314	0.5000	0.4803	0.5455	0.5627
0.5909	0.6591	0.6364	0.7418	0.6818	0.7996	0.7273	0.8289

APPENDIX III. (CONTINUED)

Time	% Comp	Time	% Comp	Time	% Comp	Time	% Comp
0.7727	0.8552	0.8182	0.8736	0.8636	0.8976	0.9091	0.9310
0.9545	0.9688	1.0000	1.0000	0.2727	0.1043	0.3182	0.1434
0.3636	0.1699	0.4091	0.2180	0.4545	0.2654	0.5000	0.3030
0.5455	0.3468	0.5909	0.4284	0.6364	0.5199	0.6818	0.5761
0.7273	0.6790	0.7727	0.7537	0.8182	0.8107	0.8636	0.8440
0.9091	0.9004	0.9545	0.9680	1.0000	1.0000	0.0000	0.0000
0.0526	0.0000	0.1053	0.0000	0.1579	0.0571	0.2105	0.0708
0.2632	0.0955	0.3158	0.1452	0.3684	0.2039	0.4211	0.2545
0.4737	0.3236	0.5263	0.4196	0.5789	0.5011	0.6316	0.5994
0.6842	0.6797	0.7368	0.7511	0.7895	0.8043	0.8421	0.8739
0.8947	0.9247	0.9474	0.9665	1.0000	1.0000	0.0000	0.0000
0.0476	0.0137	0.0952	0.0588	0.1429	0.1128	0.1905	0.2164
0.2381	0.2707	0.2857	0.3324	0.3333	0.3944	0.3810	0.4544
0.4286	0.5430	0.4762	0.6148	0.5238	0.6869	0.5714	0.7206
0.6190	0.7603	0.6667	0.8200	0.7143	0.8600	0.7619	0.8996
0.8095	0.9299	0.8571	0.9601	0.9048	0.9747	0.9524	0.9863
1.0000	1.0000	0.0000	0.0000	0.0455	0.0248	0.0909	0.0373
0.1364	0.0635	0.1818	0.0999	0.2273	0.1278	0.2727	0.1531
0.3182	0.2338	0.3636	0.2898	0.4091	0.3505	0.4545	0.4191
0.5000	0.5072	0.5455	0.6008	0.5909	0.6830	0.6364	0.7386
0.6818	0.7689	0.7273	0.8152	0.7727	0.8665	0.8182	0.9040
0.8636	0.9517	0.9091	0.9806	0.9545	0.9952	1.0000	1.0000
0.0000	0.0000	0.0500	0.0000	0.1000	0.0582	0.1500	0.0837
0.2000	0.1170	0.2500	0.1533	0.3000	0.1932	0.3500	0.2449
0.4000	0.3128	0.4500	0.3846	0.5000	0.4564	0.5500	0.5309
0.6000	0.6046	0.6500	0.6893	0.7000	0.7758	0.7500	0.8572
0.8000	0.9256	0.8500	0.9484	0.9000	0.9760	0.9500	0.9916
1.0000	1.0000	0.0000	0.0000	0.0435	0.0255	0.0870	0.0928
0.1304	0.1379	0.1739	0.1467	0.2174	0.1822	0.2609	0.2240
0.3043	0.2815	0.3478	0.3322	0.3913	0.3886	0.4348	0.4928
0.4783	0.5525	0.5217	0.6468	0.5652	0.6960	0.6087	0.7625
0.6522	0.8061	0.6957	0.8312	0.7391	0.8588	0.7826	0.8968
0.8261	0.9680	0.8696	0.9680	0.9130	0.9829	0.9565	0.9946
1.0000	1.0000	0.0000	0.0000	0.0588	0.0000	0.1176	0.0000
0.1765	0.0000	0.2353	0.0840	0.2941	0.2088	0.3529	0.2653
0.4118	0.3418	0.4706	0.4298	0.5294	0.5561	0.5882	0.6332
0.6471	0.6766	0.7059	0.7406	0.7647	0.8057	0.8235	0.8771
0.8824	0.9853	0.9412	0.9853	1.0000	1.0000	0.0000	0.0000
0.0833	0.0537	0.1667	0.1160	0.2500	0.2226	0.3333	0.3317
0.4167	0.4648	0.5000	0.5671	0.5833	0.6693	0.6667	0.7521
0.7500	0.8275	0.8333	0.9039	0.9167	0.9946	1.0000	1.0000
0.0000	0.0000	0.0769	0.0000	0.1538	0.1142	0.2308	0.2166
0.3077	0.3765	0.3846	0.4869	0.4615	0.6066	0.5385	0.6940
0.6154	0.7870	0.6923	0.8647	0.7692	0.9280	0.8462	0.9940
0.9231	0.9940	1.0000	1.0000				

APPENDIX IV. Construction Forecast Program

```
1. *:*****************************************************
2. *:         PROGRAM: PROJEST.PRG
3. *:  LAST MODIFIED: 09/28/90
4. *:  PROCS & FNCTS: ERROR
5. *:                : ESTIMATE
6. *:                : EQUALIZE
7. *:                : GATH
8. *:                : SCAT
9. *:                : SCAT1
10. *:               : GATH1
11. *:               : PROJREP
12. *:
13. *:      Calls: ERROR         (procedure in PROJEST.PRG)
14. *:           : ESTIMATE      (procedure in PROJEST.PRG)
15. *:           : EQUALIZE      (procedure in PROJEST.PRG)
16. *:           : GATH          (procedure in PROJEST.PRG)
17. *:           : SCAT          (procedure in PROJEST.PRG)
18. *:           : SCAT1         (procedure in PROJEST.PRG)
19. *:           : GATH1         (procedure in PROJEST.PRG)
20. *:           : PROJREP       (procedure in PROJEST.PRG)
21. *:           : MFORECAST()   (Dimension)
22. *:           : MFORECAST1()  (Dimension)
23. *:           : MFORECAST2()  (Dimension)
24. *:
25. *:            Uses: PROJECT.DBF
26. *:                : PROJLOAD.DBF
27. *:                : CONTRACT.DBF
28. *:                : PROJTEMP.DBF
29. *:                : TEMPS.DBF
30. *:                : STATHIST.DBF
31. *:                : TEMPS1.DBF
32. *:                : STATTEMP.DBF
33. *:                : TEMP.DBF
34. *:                : PROJECT1.DBF
35. *:                : PROJ2.DBF
36. *:
37. *:         Indexes: PROJ_NO1.IDX
38. *:                : CONTR1.IDX
39. *:                : CONTR.IDX
40. *!*****************************************************
41. CLEAR
42. CLEAR PROGRAM
43. CLEAR ALL
44. SET STATUS OFF
45. SET SAFETY OFF
46. SET TALK OFF
47. SET PROCEDURE TO PROJEST.PRG
48. ON ERROR DO ERROR WITH MESSAGE()
49. PUBLIC MCOUNT, MCOUNTER, MPROJ_NO1, MAWD_DATE
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
50. PUBLIC MFYEAR, MFYEAR1,MFYEAR2
51. MFYEAR=0
52. MFYEAR1="09/01/"
53. MFYEAR2="08/01/"
54. DO WHILE .T.
55.    CLEAR
56.    @2,10 SAY "Input the starting Fiscal Year for the
             Report - "
57.    @2,60 GET MFYEAR PICTURE "9999"
58.    READ
59.    IF MFYEAR>1980
60.       EXIT
61.    ELSE
62.       MFYEAR=0
63.       LOOP
64.    ENDIF
65. ENDDO
66. CLEAR
67. MFYEAR=MFYEAR-1
68. MFYEAR1=MFYEAR1+LTRIM(STR(MFYEAR))
69. MFYEAR2=MFYEAR2+LTRIM(STR(MFYEAR))
70. SELECT 1
71. USE TEMPFY
72. ZAP
73. APPEND BLANK
74. REPLACE FYEAR WITH MFYEAR
75. USE
76. @ 10,5 SAY" "
77. WAIT "        Make sure printer is ready, press any
                  key to continue."
78. CLEAR
79. @ 10,20 SAY "Preparing Report - This takes several
                 minutes."
80. SET CONSOLE OFF
81. SET EXCLUSIVE OFF
82. SELECT 1
83. USE PROJECT
84. ZAP
85. APPEND FROM F:\CONST\CONTRACT\DATA\PROJLOAD.DBF
86. DELETE ALL FOR SYS_NO=0
87. PACK
88. SELECT 2
89. USE CONTRACT
90. ZAP
91. APPEND FROM F:\CONST\CONTRACT\DATA\CONTRACT.DBF
92. USE
93. USE CONTRACT INDEX PROJ_NO1
94. REINDEX
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
95. SELECT 3
96. USE PROJTEMP
97. ZAP
98. SELECT 1
99. GOTO TOP
100. DO WHILE .NOT. EOF()
101.    MCOUNTER=0
102.    MCOUNT=1
103.    STORE PROJ_NO1 TO MPROJ_NO1
104.    SELECT 3
105.    COUNT TO MCOUNTER FOR PROJTEMP->PROJ_NO1=MPROJ_NO1
106.    SELECT 2
107.    COUNT TO MCOUNT FOR CONTRACT->PROJ_NO1=MPROJ_NO1
108.    IF MCOUNT>1
109.       IF MCOUNTER=0
110.          COPY TO TEMPS FOR PROJ_NO1=MPROJ_NO1
111.       ENDIF
112.    ENDIF
113.    SELECT 1
114.    SET RELATION TO PROJ_NO1 INTO CONTRACT
115.    DO CASE
116.    CASE MCOUNT=1
117.       IF CONTRACT->CURR_AMT1>0
118.          REPLACE ORIG_AMT WITH
                  CONTRACT->CURR_AMT1/1000
119.       ELSE
120.          IF CONTRACT->ORIG_AMT1>0
121.             REPLACE ORIG_AMT WITH
                        CONTRACT->ORIG_AMT1/1000
122.          ENDIF
123.       ENDIF
124.       IF .NOT. EMPTY(CONTRACT->START_DATE)
125.          REPLACE START_DATE WITH CONTRACT->START_DATE
126.          REPLACE ACT WITH "*"
127.       ENDIF
128.       IF CONTRACT->CURR_DAYS>0
129.          REPLACE DURATION WITH
                     ROUND((CONTRACT->CURR_DAYS/30),0)
130.          STORE CONTRACT->CURR_DAYS TO MDURT
131.       ELSE
132.          IF CONTRACT->ORIG_DAYS>0
133.             REPLACE DURATION WITH
                        ROUND((CONTRACT->ORIG_DAYS/30),0)
134.             STORE CONTRACT->ORIG_DAYS TO MDURT
135.          ENDIF
136.       ENDIF
137.       IF .NOT. EMPTY(START_DATE)
138.          REPLACE FORECASTDT WITH START_DATE+MDURT
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
139.        ENDIF
140.        REPLACE AWARDED WITH
                ORIG_AMT-(CONTRACT->EARNED1/1000)
141.        REPLACE CONTR_NO WITH CONTRACT->CONTR_NO
142.     CASE MCOUNT>1
143.        STORE AWD_DATE TO MAWD_DATE
144.        DELETE
145.        SELECT 3
146.        IF MCOUNTER=0
147.           APPEND FROM TEMPS
148.           REPLACE ALL AWD_DATE WITH
                   MAWD_DATE FOR MPROJ_NO1=PROJ_NO1
149.           DELETE FILE TEMPS.DBF
150.        ENDIF
151.        SELECT 1
152.     OTHERWISE
153.        REPLACE UNAWARDED WITH ORIG_AMT
154.        IF .NOT. EMPTY(START_DATE)
155.           REPLACE FORECASTDT WITH
                   START_DATE+(DURATION*30)
156.        ENDIF
157.     ENDCASE
158.     SKIP
159. ENDDO
160. SELECT 3
161. DELETE ALL FOR VAL(PART)>1 .AND.
        FORECASTDT<CTOD(MFYEAR1)
162. PACK
163. GOTO TOP
164. DO WHILE .NOT. EOF()
165.     IF CURR_AMT1>0
166.        REPLACE ORIG_AMT WITH CURR_AMT1/1000
167.     ELSE
168.        IF ORIG_AMT1>0
169.           REPLACE ORIG_AMT WITH ORIG_AMT1/1000
170.        ENDIF
171.     ENDIF
172.     IF CURR_DAYS>0
173.        REPLACE DURATION WITH ROUND((CURR_DAYS/30),0)
174.        STORE CURR_DAYS TO MDURT
175.     ELSE
176.        IF ORIG_DAYS>0
177.           REPLACE DURATION WITH
                   ROUND((ORIG_DAYS/30),0)
178.           STORE ORIG_DAYS TO MDURT
179.        ENDIF
180.     ENDIF
181.     IF .NOT. EMPTY(START_DATE)
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
182.        REPLACE FORECASTDT WITH START_DATE+MDURT
183.        REPLACE ACT WITH "*"
184.     ELSE
185.        IF DURATION>0
186.           IF .NOT. EMPTY(AWD_DATE)
187.              REPLACE START_DATE WITH AWD_DATE+60
188.              REPLACE FORECASTDT WITH
                      START_DATE+(DURATION*30)
189.           ENDIF
190.        ELSE
191.           REPLACE FORECASTDT WITH START_DATE
192.           REPLACE DURATION WITH 0
193.        ENDIF
194.     ENDIF
195.     REPLACE AWARDED WITH ORIG_AMT-(EARNED1/1000)
196.     SKIP
197. ENDDO
198. CLOSE ALL
199. USE PROJECT
200. APPEND FROM PROJTEMP
201. PACK
202. USE
203. SELECT 2
204. USE F:\CONST\CONTRACT\DATA\STATHIST.DBF
205. COPY TO TEMPS1 FOR STATUSDATE>CTOD(MFYEAR2)
206. USE STATTEMP INDEX CONTR1
207. REINDEX
208. ZAP
209. APPEND FROM TEMPS1
210. GOTO BOTTOM
211. STORE STATUSDATE TO MDATE
212. APPEND FROM CONTRACT FOR STATUSDATE>MDATE
213. SELECT 8
214. USE TEMPFY
215. REPLACE CURDATE WITH MDATE
216. USE
217. SELECT 1
218. USE PROJECT INDEX CONTR
219. REINDEX
220. SELECT 2
221. SET RELATION TO CONTR_NO INTO PROJECT
222. GOTO TOP
223. DO WHILE .NOT. EOF()
224.     IF CONTR_NO<>PROJECT->CONTR_NO
225.        DELETE
226.     ENDIF
227.     SKIP
228. ENDDO
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
229. PACK
230. SET RELATION TO
231. SELECT 1
232. CLOSE INDEX
233. SORT ON SYS_NO, PROJ_NO1 TO TEMP
234. ZAP
235. APPEND FROM TEMP
236. DELETE FILE TEMP.DBF
237. CLOSE ALL
238. SELECT 2
239. USE PROJECT1
240. ZAP
241. APPEND FROM PROJECT
242. SELECT 1
243. USE PROJECT
244. PUBLIC MEST,MESTL,MDUR,FORNUM
245. PUBLIC ARRAY MFORECAST (1,37)
246. DO WHILE .NOT. EOF()
247.    IF .NOT. EMPTY(START_DATE)
248.       DIMENSION MFORECAST (1,37)
249.       STORE 0 TO MFORECAST
250.       IF .NOT. EMPTY(NFORDATE)
251.          MDUR=INT(ROUND((NFORDATE-START_DATE)/30,0))
252.          REPLACE ACT WITH "-"
253.          REPLACE DURATION WITH MDUR
254.          REPLACE FORECASTDT WITH NFORDATE
255.       ELSE
256.          STORE DURATION TO MDUR
257.       ENDIF
258.       STORE ORIG_AMT TO MORIG
259.       STORE CTOD(MFYEAR2) TO MNUMB
260.       MDATE = INT((START_DATE-MNUMB)/30)
261.       IF DAY(START_DATE)>15
262.          MDATE=MDATE+1
263.          MDUR=MDUR-1
264.       ENDIF
265.       FORNUM=0
266.       CNT=1
267.       MESTL=0
268.       IF MDATE>-1
269.          DO WHILE MDUR-FORNUM>0
270.             FORNUM=FORNUM+1
271.             DO ESTIMATE
272.             IF MDATE+1+FORNUM<38
273.                STORE MEST TO
                       MFORECAST(MDATE+1+FORNUM)
274.             ENDIF
275.          ENDDO
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
276.            DO EQUALIZE
277.            DO GATH
278.         ELSE
279.            FORNUM=ABS(MDATE)-1
280.            IF MDUR-FORNUM <=0
281.               IF AWARDED=ORIG_AMT .AND. .NOT.
                        EMPTY(FORECASTDT) .AND.
                         CTOD("08/01/"+
                         LTRIM(STR(MFYEAR)))<FORECASTDT
282.                  SELECT 8
283.                  USE TEMPFY
284.                  MDATE=CURDATE
285.                     USE
286.                     SELECT 1
287.                  CNT=(MONTH(MDATE)-7)+((YEAR(MDATE)
                          -MFYEAR)*12)+1
288.                  IF CNT<2
289.                     CNT=2
290.                  ENDIF
291.                  IF CNT>37
292.                     CNT=37
293.                  ENDIF
294.                  STORE ORIG_AMT TO MFORECAST(CNT)
295.               ENDIF
296.             ENDIF
297.             DO WHILE MDUR-FORNUM>0
298.               FORNUM=FORNUM+1
299.               DO ESTIMATE
300.               STORE MEST TO MFORECAST(CNT)
301.               CNT=CNT+1
302.            ENDDO
303.            DO EQUALIZE
304.            DO GATH
305.         ENDIF
306.      ELSE
307.         REPLACE DURATION WITH 0
308.      ENDIF
309.      SKIP
310.  ENDDO
311.  SELECT 3
312.  USE STATTEMP INDEX CONTR1
313.  REINDEX
314.  SELECT 2
315.  GOTO TOP
316.  DO WHILE .NOT. EOF()
317.     IF .NOT. EMPTY(CONTR_NO)
318.        STORE PROJ_NO1 TO MPROJ_NO1
319.        STORE CONTR_NO TO MCONTR_NO
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
320.
321.        DIMENSION MFORECAST (1,37)
322.
323.        SELECT 3
324.        PUBLIC MSTATUS
325.        STORE CTOD("  /  /  ") TO MSTATUS
326.        GOTO TOP
327.        DO WHILE .NOT. EOF()
328.           IF MCONTR_NO=CONTR_NO
329.              IF EARNED1<>0 .OR. EARNED2<>0 .OR.
                       EARNLAST1<>0 .OR. EARNLAST2<>0
330.                 IF MPROJ_NO1=PROJ_NO1
331.                    STORE STATUSDATE TO MSTATUS
332.                    MTIME=(MONTH(STATUSDATE)-7)
                           +((YEAR(STATUSDATE)-MFYEAR)*12)
333.                    IF MTIME <0
334.                    MTIME=0
335.                    ENDIF
336.                    IF MTIME <37
337.                       IF MTIME>1
338.                          STORE ((EARNED1 -
                                EARNLAST1)/1000) TO
                                MFORECAST(MTIME+1)
339.                       ELSE
340.                          STORE (EARNLAST1/1000) TO
                                MFORECAST(1)
341.                          STORE ((EARNED1 -
                                EARNLAST1)/1000) TO
                                MFORECAST(MTIME+1)
342.                       ENDIF
343.                    ENDIF
344.                 ENDIF
345.                 IF MPROJ_NO1=PROJ_NO2
346.                    STORE STATUSDATE TO MSTATUS
347.                    MTIME=(MONTH(STATUSDATE) - 7)
                          +((YEAR(STATUSDATE)-MFYEAR)*12)
348.                    IF MTIME <0
349.                    MTIME=0
350.                    ENDIF
351.                    IF MTIME <37
352.                       IF MTIME>1
353.                          STORE ((EARNED1 -
                                EARNLAST1)/1000) TO
                                MFORECAST(MTIME+1)
354.                       ELSE
355.                          STORE (EARNLAST1/1000) TO
                                MFORECAST(1)
356.                          STORE ((EARNED1 -
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
                                        EARNLAST1)/1000) TO
                                        MFORECAST(MTIME+1)
357.                          ENDIF
358.                       ENDIF
359.                    ENDIF
360.                 ENDIF
361.              ENDIF
362.              SKIP
363.           ENDDO
364.           SELECT 2
365.           REPLACE STATUSDATE WITH MSTATUS
366.           STORE CTOD("  /  /  ") TO MSTATUS
367. IF UNAWARDED=0
368. MTT=0
369. FOR MT = 2 TO 37
370.    IF .NOT. EMPTY(MFORECAST(MT))
371.    MTT=MTT+MFORECAST(MT)
372.    ENDIF
373. ENDFOR
374. MFORECAST(1)=ORIG_AMT-AWARDED-MTT
375. ENDIF
376.          DO GATH
377.    ENDIF
378.    SKIP
379. ENDDO
380. CLEAR MEMORY
381. SELECT 3
382. USE TEMPFY
383. GOTO TOP
384. STORE FYEAR TO MFYEAR
385. ZAP
386. USE
387. SELECT 1
388. GOTO TOP
389. SET RELATION TO RECNO() INTO PROJECT1
390. PUBLIC ARRAY MFORECAST (1,37)
391. PUBLIC ARRAY MFORECAST1 (1,37)
392. PUBLIC ARRAY MFORECAST2 (1,37)
393. DO WHILE .NOT. EOF()
394.    MCOUNT=0
395.    MTIME=0
396.    IF .NOT. EMPTY (PROJECT1->STATUSDATE)
397.    IF STATUSDATE>CTOD("07/01/"+LTRIM(STR(MFYEAR)))
398.       REPLACE STATUSDATE WITH PROJECT1->STATUSDATE
399.       DIMENSION MFORECAST (1,37)
400.       DIMENSION MFORECAST1 (1,37)
401.       DIMENSION MFORECAST2 (1,37)
402.       DO SCAT
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
403.        SELECT 2
404.        DO SCAT1
405.        SELECT 1
406.        MTIME=(MONTH(STATUSDATE)-7)+((YEAR(STATUSDATE)
                - MFYEAR)*12)+1
407.        IF MTIME <1
408.           MTIME=1
409.        ENDIF
410.        DO WHILE MTIME-MCOUNT>0
411.           MCOUNT=MCOUNT+1
412.           IF MFORECAST(MCOUNT)>0 .OR.
                  MFORECAST1(MCOUNT)>0
413.              STORE MFORECAST1(MCOUNT) TO
                     MFORECAST2(MCOUNT)
414.           ELSE
415.              LOOP
416.           ENDIF
417.        ENDDO
418.        MTOTAL1=0
419.        MCOUNT2=0
420.        STORE .T. TO MFLAG
421.        MCOUNT1=MCOUNT
422.        DO WHILE MFORECAST(MCOUNT+1)=0
423.           MCOUNT=MCOUNT+1
424.           IF MCOUNT>36
425.              MCOUNT=MCOUNT1
426.              EXIT
427.           ENDIF
428.           LOOP
429.        ENDDO
430.        MCOUNT1=MCOUNT
431.        DO WHILE MFLAG
432.           MCOUNT=MCOUNT+1
433.           IF MCOUNT<37
434.              IF MFORECAST(MCOUNT)=0
435.                 STORE .F. TO MFLAG
436.              ELSE
437.                 MTOTAL1=MTOTAL1+MFORECAST(MCOUNT)
438.                 MCOUNT2=MCOUNT2+1
439.              ENDIF
440.            ELSE
441.              EXIT
442.            ENDIF
443.           LOOP
444.        ENDDO
445.        IF MCOUNT2=0
446.           STORE AWARDED TO MFORECAST2(MCOUNT)
447.        ELSE
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
448.            MCOUNT=MCOUNT1
449.            DO WHILE MCOUNT1+MCOUNT2-MCOUNT>0
450.               MCOUNT=MCOUNT+1
451.               MTOT=(AWARDED-MTOTAL1) *
                        (MFORECAST(MCOUNT)/MTOTAL1)
452.               STORE MFORECAST(MCOUNT)+MTOT TO
                     MFORECAST2(MCOUNT)
453.               LOOP
454.            ENDDO
455.         ENDIF
456.         DO GATH1
457.      ENDIF
458.      ENDIF
459.      SKIP
460. ENDDO
461. GOTC TOP
462. SUM SEP1 + OCT1 + NOV1 + DEC1 + JAN1 + FEB1 + MAR1 +
         APR1 + MAY1 + JUN1 + JUL1 + AUG1 TO MTOT1
463. SUM SEP2 + OCT2 + NOV2 + DEC2 + JAN2 + FEB2 + MAR2 +
         APR2 + MAY2 + JUN2 + JUL2 + AUG2 TO MTOT2
464. SUM SEP3 + OCT3 + NOV3 + DEC3 + JAN3 + FEB3 + MAR3 +
         APR3 + MAY3 + JUN3 + JUL3 + AUG3 TO MTOT3
465. GOTO TOP
466. DO WHILE .NOT. EOF()
467.    REPLACE FY1 WITH SEP1 + OCT1 + NOV1 + DEC1 + JAN1
          + FEB1 + MAR1 + APR1 + MAY1 + JUN1 + JUL1 + AUG1
468.    REPLACE FY2 WITH SEP2 + OCT2 + NOV2 + DEC2 + JAN2
          + FEB2 + MAR2 + APR2 + MAY2 + JUN2 + JUL2 + AUG2
469.    REPLACE FY3 WITH SEP3 + OCT3 + NOV3 + DEC3 + JAN3
          + FEB3 + MAR3 + APR3 + MAY3 + JUN3 + JUL3 + AUG3
470.    REPLACE FY1P WITH FY1/MTOT1*100
471.    REPLACE FY2P WITH FY2/MTOT2*100
472.    REPLACE FY3P WITH FY3/MTOT3*100
473.    SKIP
474. ENDDO
475. DO PROJREP
476. CLOSE ALL
477. CLEAR ALL
478. DELETE FILE PROJ2.DBF
479. DELETE FILE TEMPS1.DBF
480. SET SAFETY ON
481. SET DEVICE TO SCREEN
482. SET CONSOLE ON
483. CLOSE PROCEDURE PROJEST
484. QUIT
485. *!*************************************************
486. *!
487. *!    PROCEDURE: GATH1
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
*!
*!     CALLED BY: PROJEST.PRG
*!
*!*************************************************
PROCEDURE GATH1
GATHER FROM MFORECAST2 FIELDS AUG0, SEP1, OCT1, NOV1,
       DEC1, JAN1, FEB1, MAR1, APR1, MAY1, JUN1, JUL1,
       AUG1, SEP2, OCT2, NOV2, DEC2, JAN2, FEB2, MAR2,
       APR2, MAY2, JUN2, JUL2, AUG2, SEP3, OCT3, NOV3,
       DEC3, JAN3, FEB3, MAR3, APR3, MAY3, JUN3, JUL3,
       AUG3
RETURN
*!*************************************************
*!
*!     PROCEDURE: SCAT
*!
*!     CALLED BY: PROJEST.PRG
*!              : PROJREP (PROCEDURE IN PROJEST.PRG)
*!
*!*************************************************
PROCEDURE SCAT
SCATTER TO MFORECAST FIELDS AUG0, SEP1, OCT1, NOV1,
      DEC1, JAN1, FEB1, MAR1, APR1, MAY1, JUN1, JUL1,
      AUG1, SEP2, OCT2, NOV2, DEC2, JAN2, FEB2, MAR2,
      APR2, MAY2, JUN2, JUL2, AUG2, SEP3, OCT3, NOV3,
      DEC3, JAN3, FEB3, MAR3, APR3, MAY3, JUN3, JUL3,
      AUG3
RETURN
*!*************************************************
*!
*!     PROCEDURE: SCAT1
*!
*!     CALLED BY: PROJEST.PRG
*!              : PROJREP (PROCEDURE IN PROJEST.PRG)
*!
*!*************************************************
PROCEDURE SCAT1
SCATTER TO MFORECAST1 FIELDS AUG0, SEP1, OCT1, NOV1,
      DEC1, JAN1, FEB1, MAR1, APR1, MAY1, JUN1, JUL1,
      AUG1, SEP2, OCT2, NOV2, DEC2, JAN2, FEB2, MAR2,
      APR2, MAY2, JUN2, JUL2, AUG2, SEP3, OCT3, NOV3,
      DEC3, JAN3, FEB3, MAR3, APR3, MAY3, JUN3, JUL3,
      AUG3
RETURN
*!*************************************************
*!
*!     PROCEDURE: GATH
*!
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
521. *!     CALLED BY: PROJEST.PRG
522. *!              : PROJREP (PROCEDURE IN PROJEST.PRG)
523. *!
524. *!*************************************************
525. PROCEDURE GATH
526. GATHER FROM MFORECAST FIELDS AUG0, SEP1, OCT1, NOV1,
           DEC1, JAN1, FEB1, MAR1, APR1, MAY1, JUN1, JUL1,
           AUG1, SEP2, OCT2, NOV2, DEC2, JAN2, FEB2, MAR2,
           APR2, MAY2, JUN2, JUL2, AUG2, SEP3, OCT3, NOV3,
           DEC3, JAN3, FEB3, MAR3, APR3, MAY3, JUN3, JUL3,
           AUG3
527. RETURN
528. *!*************************************************
529. *!
530. *!     PROCEDURE: ESTIMATE
531. *!
532. *!     CALLED BY: PROJEST.PRG
533. *!
534. *!*************************************************
535. PROCEDURE ESTIMATE
536. FNUM=FORNUM/MDUR
537. IF MORIG<3000
538.    MES=(-0.00152+0.61578*FNUM+1.56162*FNUM^2 -
            0.90625*FNUM^3-0.27169*FNUM^4)*MORIG
539. ELSE
540.    IF MORIG>7000
541.       MES=(0.0024+0.190081*FNUM+2.36807*FNUM^2 -
               1.42462*FNUM^3-0.14005*FNUM^4)*MORIG
542.    ELSE
543.       MES=(-0.00063+0.16453*FNUM+3.36899*FNUM^2 -
               3.441*FNUM^3+0.91039*FNUM^4)*MORIG
544.    ENDIF
545. ENDIF
546. MEST=MES-MESTL
547. MESTL=MES
548. RETURN
549. *!*************************************************
550. *!
551. *!     PROCEDURE: EQUALIZE
552. *!
553. *!     CALLED BY: PROJEST.PRG
554. *!
555. *!         CALLS: MFORECAST()   (DIMENSION)
556. *!
557. *!*************************************************
558. PROCEDURE EQUALIZE
559. MTOT=0
560. MTOTAL=0
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
561. FOR CCNT= 1 TO 37
562.    IF MFORECAST(CCNT)<>0
563.       MTOTAL=MFORECAST(CCNT)+MTOTAL
564.    ENDIF
565. ENDFOR
566. IF MFORECAST(37)=0
567.    FOR CCNT= 1 TO 37
568.       IF MFORECAST(CCNT)<>0
569.          MTOT=(ORIG_AMT-MTOTAL) *
                    (MFORECAST(CCNT)/MTOTAL)
570.          STORE MFORECAST(CCNT)+MTOT TO
                    MFORECAST(CCNT)
571.       ENDIF
572.    ENDFOR
573. ENDIF
574. RETURN
575. *!*************************************************
576  *!
577. *!    PROCEDURE: PROJREP
578. *!
579. *!    CALLED BY: PROJEST.PRG
580. *!
581. *!         CALLS: GATH     (PROCEDURE IN PROJEST.PRG)
582. *!              : SCAT     (PROCEDURE IN PROJEST.PRG)
583. *!              : SCAT1    (PROCEDURE IN PROJEST.PRG)
584. *!
585. *!          USES: PROJECT.DBF
586. *!              : TEMPS1.DBF
587. *!              : CONTRACT.DBF
588. *!              : PROJ1.DBF
589. *!              : PROJ2.DBF
590. *!
591. *! REPORT FORMS: PROJECT.FRX
592. *!              : PROJECT1.FRX
593. *!
594. *!*************************************************
595. PROCEDURE PROJREP
596. CLOSE ALL
597. USE PROJECT
598. GOTO TOP
599. MCOUNTS=1
600. MCOUNTER=1
601. STORE SYS_NO TO MSYS
602. DO WHILE .NOT. EOF()
603.    IF SYS_NO=MSYS
604.       IF MCOUNTER<=3
605.          REPLACE MROW WITH MCOUNTS
606.          MCOUNTER=MCOUNTER+1
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
607.          ELSE
608.             MCOUNTS=MCOUNTS+1
609.             MCOUNTER=2
610.             REPLACE MROW WITH MCOUNTS
611.          ENDIF
612.       ELSE
613.          MCOUNTS=1
614.          MCOUNTER=1
615.          REPLACE MROW WITH MCOUNTS
616.          MCOUNTER=2
617.       ENDIF
618.       STORE SYS_NO TO MSYS
619.       SKIP
620. ENDDO
621. SELECT 2
622. PUBLIC ARRAY MFORECAST (1,37)
623. PUBLIC CCNT, MSTATUS
624. MSTATUS=CTOD("  /  /  ")
625. USE TEMPS1
626. APPEND FROM CONTRACT FOR PART='1' .OR. PART='2'
627. GOTO TOP
628. DELETE ALL FOR STATUSDATE < CTOD("08/01/" +
         LTRIM(STR(MFYEAR)))
629. PACK
630. GOTO TOP
631. CCNT=2
632. DIMENSION MFORECAST(1,37)
633. DO WHILE .NOT. EOF()
634.    STORE STATUSDATE TO MSTATUS
635.    SUM ((EARNED1-EARNLAST1+EARNED2-EARNLAST2)/1000)
            TO MSUM WHILE MSTATUS=STATUSDATE
636.    STORE MSUM TO MFORECAST(CCNT)
637.    CCNT=CCNT+1
638.    IF CCNT>37
639.       EXIT
640.    ENDIF
641. ENDDO
642. SELECT 3
643. USE PROJ1
644. ZAP
645. APPEND BLANK
646. GOTO TOP
647. DO GATH
648. REPLACE STATUSDATE WITH MSTATUS
649. USE
650. COPY FILE PROJ1.DBF TO PROJ2.DBF
651. USE PROJ1
652. SELECT 2
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
653. USE PROJ2
654. ZAP
655. APPEND BLANK
656. GOTO TOP
657. SELECT 1
658. USE PROJECT
659. PUBLIC ARRAY MFORECAST(1,37)
660. PUBLIC ARRAY MFORECAST1(1,37)
661. DIMENSION MFORECAST(1,37)
662. DIMENSION MFORECAST1(1,37)
663. FOR CCNT = 1 TO 37 STEP 1
664.    MFORECAST1(CCNT)=0
665. ENDFOR
666. GOTO TOP
667. DO WHILE .NOT. EOF()
668.    DO SCAT
669.    FOR CCNT = 1 TO 37 STEP 1
670.       MFORECAST1(CCNT) = MFORECAST(CCNT) +
                              MFORECAST1(CCNT)
671.    ENDFOR
672.    SKIP
673. ENDDO
674. SELECT 2
675. FOR CCNT = 1 TO 37 STEP 1
676.    MFORECAST(CCNT)=MFORECAST1(CCNT)
677. ENDFOR
678. DO GATH
679. SELECT 3
680. GOTO TOP
681. DIMENSION MFORECAST1(1,37)
682. DO SCAT1
683. SELECT 2
684. GOTO TOP
685. DO SCAT
686. CCNT=2
687. DO WHILE MFORECAST1(CCNT)>0
688.    STORE MFORECAST1(CCNT) TO MFORECAST(CCNT)
689.    CCNT=CCNT+1
690.    IF CCNT>37
691.       EXIT
692.    ENDIF
693. ENDDO
694. DO GATH
695. SELECT 1
696. GOTO TOP
697. DO WHILE .NOT. EOF()
698.    IF UNAWARDED=0 .AND. SEP1=0 .AND.
            FORECASTDT<CTOD("08/01/"+LTRIM(STR(MFYEAR)))
```

APPENDIX IV. (PROJEST.PRG CONTINUED)

```
699.        REPLACE AUG0 WITH ORIG_AMT
700.     ENDIF
701.     IF UNAWARDED>0 .AND. .NOT. EMPTY(AWD_DATE) .AND.
             AWD_DATE<CTOD("08/31/"+LTRIM(STR(MFYEAR)))
702.        REPLACE AWARDED WITH UNAWARDED
703.        REPLACE UNAWARDED WITH 0
704.        IF EMPTY(AUG0)
705.           REPLACE AUG0 WITH ORIG_AMT
706.        ENDIF
707.     ENDIF
708.     SKIP
709. ENDDO
710. GOTO TOP
711. SET DEVICE TO PRINTER
712. REPORT FORM PROJECT NOEJECT OFF TO PROJECT.TXT
713. REPORT FORM PROJECT1  NOEJECT OFF TO PROJECT1.TXT
714. RUN SIDEWAYS PROJECT.TXT
715. RUN SIDEWAYS PROJECT1.TXT
716. EJECT
717. RETURN
718. *!*************************************************
719. *!
720. *!     PROCEDURE: ERROR
721. *!
722. *!     CALLED BY: PROJEST.PRG
723. *!
724. *!*************************************************
725. PROCEDURE ERROR
726. PARAMETERS MESS
727. SET CONSOLE ON
728. CLEAR
729. @ 12,10 SAY MESS
730. @ 14,10 SAY "PLEASE TRY AGAIN LATER"
731. @ 15,10 SAY " "
732. WAIT "          PRESS ANY KEY TO EXIT PROGRAM"
733. ON ERROR
734. SET SAFETY ON
735. SET DEVICE TO SCREEN
736. CLOSE PROCEDURE
737. CLOSE ALL
738. CLEAR ALL
739. QUIT
740. *: EOF: PROJEST.PRG
```

APPENDIX V. Construction Time Sheet Program

```
1. *!*************************************************
2. *:         PROGRAM: COSTS.PRG
3. *:  LAST MODIFIED: 09/06/90     10:52
4. *:  PROCS & FNCTS: EDITING
5. *:                : EMPLOYEE
6. *:                : DISPFORM
7. *:                : ADDREC
8. *:                : COPYING
9. *:                : WEEKLY
10. *:               : INDIVIDUAL
11. *:               : ACTSUM
12. *:               : TASKS
13. *:               : CONTRACT
14. *:               : DISPREC
15. *:               : EDITREC
16. *:               : BLANKREC
17. *:               : REPLREC
18. *:               : PROJNAME
19. *:               : GETADATE
20. *:               : GETDATES
21. *:               : SEARCH
22. *:               : SUMM
23. *:               : ACTIVE
24. *:               : BSEARCH
25. *:               : TASKNO
26. *:               : TIME
27. *:               : INTIALIZE
28. *:               : SUMM1
29. *:               : ERRPROC
30. *:
31. *:          CALLS: EDITING     (PROCEDURE IN COSTS.PRG)
32. *:               : EMPLOYEE    (PROCEDURE IN COSTS.PRG)
33. *:               : DISPFORM    (PROCEDURE IN COSTS.PRG)
34. *:               : ADDREC      (PROCEDURE IN COSTS.PRG)
35. *:               : COPYING     (PROCEDURE IN COSTS.PRG)
36. *:               : WEEKLY      (PROCEDURE IN COSTS.PRG)
37. *:               : INDIVIDUAL  (PROCEDURE IN COSTS.PRG)
38. *:               : ACTSUM      (PROCEDURE IN COSTS.PRG)
39. *:               : TASKS       (PROCEDURE IN COSTS.PRG)
40. *:               : CONTRACT    (PROCEDURE IN COSTS.PRG)
41. *:
42. *:           USES: STAFF.DBF
43. *:               : COSTS.DBF
44. *:               : TEMP.DBF
45. *:               : TEMP1.DBF
46. *:
47. *!*************************************************
48. SET ESCAPE ON
49. SET TALK OFF
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
50. SET STATUS OFF
51. SET BELL OFF
52. SET SCOREBOARD OFF
53. SET SAFETY OFF
54. SET CONSOLE OFF
55. SET CONFIRM OFF
56. SET EXCLUSIVE ON
57. SET DEFAULT TO F:\CONST\TIME
58. SET PROCEDURE TO COSTS
59. CLEAR
60. @10,15 SAY 'PLEASE WAIT - SETTING UP PROGRAM
        VARIABLES'
61. CLOSE ALL
62. SELECT 2
63. USE STAFF
64. * ---INITIALIZE DATABASE FILE.
65. SELECT 1
66. USE COSTS
67. SET COLOR TO GR+/B,N/W
68. DEFINE POPUP EMPLOYEE FROM 2,35 PROMPT FIELD
        STAFF->NAME COLOR SCHEME 15
69. ON SELECTION POPUP EMPLOYEE DEACTIVATE POPUP
70. DEFINE POPUP CHOICES FROM 10,33 COLOR SCHEME 15
71. DEFINE BAR 1 OF CHOICES PROMPT '  CHOSE OPTION  ' SKIP
72. DEFINE BAR 2 OF CHOICES PROMPT '  ' SKIP
73. DEFINE BAR 3 OF CHOICES PROMPT '\<QUIT'
74. DEFINE BAR 4 OF CHOICES PROMPT '\<EDIT DATA'
75. DEFINE BAR 5 OF CHOICES PROMPT '\<APPEND DATA'
76. DEFINE BAR 6 OF CHOICES PROMPT '\<PRINT REPORTS'
77. ON SELECTION POPUP CHOICES DEACTIVATE POPUP
78. DEFINE POPUP REPORTS FROM 4,5 COLOR SCHEME 15
79. DEFINE BAR 1 OF REPORTS PROMPT '   CHOSE PRINT OPTION'
        SKIP
80. DEFINE BAR 2 OF REPORTS PROMPT '  ' SKIP
81. DEFINE BAR 3 OF REPORTS PROMPT '\<QUIT'
82. DEFINE BAR 4 OF REPORTS PROMPT '\<WEEKLY SUMMARY'
83. DEFINE BAR 5 OF REPORTS PROMPT '\<INDIVIDUAL WEEKLY
        SUMMARY'
84. DEFINE BAR 6 OF REPORTS PROMPT '\<ACTIVITY SUMMARY'
85. DEFINE BAR 7 OF REPORTS PROMPT '\<TASKS SUMMARY'
86. DEFINE BAR 8 OF REPORTS PROMPT '\<CONTRACT SUMMARY'
87. ON SELECTION POPUP REPORTS DEACTIVATE POPUP
88. DEFINE POPUP DATES FROM 3,35 PROMPT FIELD TEMP1->WEEK
        COLOR SCHEME 15
89. ON SELECTION POPUP DATES DEACTIVATE POPUP
90. * ---DECLARE PUBLIC MEMVARS TO STORE FIELD VALUES.
91. PUBLIC MNAME
92. PUBLIC MWEEK
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
93. PUBLIC MWEEK1
94. PUBLIC MACTIVITY
95. PUBLIC MTASK
96. PUBLIC MTIME
97. PUBLIC MPROMPT
98. PUBLIC MCHOICE
99. PUBLIC MLASTNAME
100. PUBLIC MCOUNTER
101. PUBLIC MCOUNT
102. PUBLIC MSALARY
103. PUBLIC MAXTIME
104. PUBLIC MINTIME
105. MCOUNT=0
106. GO BOTTOM
107. MWEEK=WEEK+7
108. GO TOP
109. DO WHILE .T.
110.    CLEAR
111.    ACTIVATE POPUP CHOICES
112.    DO CASE
113.    CASE PROMPT()='EDIT DATA'
114.       DO EDITING
115.    CASE PROMPT()='APPEND DATA'
116.       * ---DISPLAY SCREEN FORMAT.
117.       CLEAR
118.       MWEEK1=MWEEK
119.       @ 2,10 SAY 'INPUT THE DATE'
120.       @ 2, 30 GET MWEEK1
121.       READ
122.       COPY STRUCTURE TO TEMPAPP.DBF
123.       SELECT 10
124.       USE TEMPAPP
125.       DO WHILE .T.
126.          CLEAR
127.          DO EMPLOYEE
128.          DO DISPFORM
129.          DO ADDREC
130.          IF MCHOICE="E"
131.             USE
132.             SELECT 1
133.             APPEND FROM TEMPAPP.DBF
134.             DELETE FILE TEMPAPP.DBF
135.             GO TOP
136.             EXIT
137.          ENDIF
138.       ENDDO
139.    CASE PROMPT()='PRINT REPORTS'
140.       DO COPYING
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
141.        MCOUNTER=0
142.        DO WHILE .T.
143.           ACTIVATE POPUP REPORTS
144.           DO CASE
145.           CASE PROMPT()='WEEKLY SUMMARY'
146.              DO WEEKLY
147.           CASE PROMPT()='INDIVIDUAL WEEKLY SUMMARY'
148.              DO INDIVIDUAL
149.           CASE PROMPT()='ACTIVITY SUMMARY'
150.              DO ACTSUM
151.           CASE PROMPT()='TASKS SUMMARY'
152.              DO TASKS
153.           CASE PROMPT()='CONTRACT SUMMARY'
154.              DO CONTRACT
155.           CASE PROMPT()='QUIT'
156.              EXIT
157.           ENDCASE
158.        ENDDO
159.     CASE PROMPT()='QUIT'
160.        EXIT
161.     ENDCASE
162. ENDDO
163. * ---CLOSING OPERATIONS.
164. SET COLOR TO W+/B,N/W
165. CLOSE DATABASE
166. CLEAR
167. IF FILE('TEMP.DBF')
168.    DELETE FILE TEMP.DBF
169. ENDIF
170. IF FILE('TEMP1.DBF')
171.    DELETE FILE TEMP1.DBF
172. ENDIF
173. SET SAFETY ON
174. SET SCOREBOARD ON
175. SET BELL ON
176. SET CONSOLE ON
177. SET TALK ON
178. SET STATUS ON
179. SET CONFIRM ON
180. QUIT
181. * END OF MAIN PROGRAM - PROCEDURES FOLLOW
182. *!*************************************************
183. *!
184. *!       PROCEDURE: DISPFORM
185. *!
186. *!       CALLED BY: COSTS.PRG
187. *!                : EDITING  (PROCEDURE IN COSTS.PRG)
188. *!
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
189. *!*************************************************
190. PROCEDURE DISPFORM
191. CLEAR
192. @ 0, 0 SAY SPACE(80)
193. @ 0,72 SAY DATE()
194. SET COLOR TO W+/B,N/W
195. @ 6,19 SAY "  NAME    "
196. @ 8,36 SAY "WEEK OF    "
197. @ 10,19 SAY "ACTIVITY  "
198. @ 10,34 SAY "TASK      "
199. @ 10,45 SAY "TIME      "
200. @ 5,14,15,57 BOX "╔═╗║╝═╚║"
201. RETURN
202. *!*************************************************
203. *!
204. *!      PROCEDURE: DISPREC
205. *!
206. *!      CALLED BY: EDITING  (PROCEDURE IN COSTS.PRG)
207. *!
208. *!*************************************************
209. PROCEDURE DISPREC
210. @ 0, 0 SAY "RECORD: "+ SUBSTR(STR(RECNO()
          +1000000,7),2)
211. IF DELETED()
212.    @ 0,50 SAY "*DELETED*"
213. ELSE
214.    @ 0,50 SAY "          "
215. ENDIF
216. SET COLOR TO GR+/B,N/W
217. @ 6,29 SAY NAME
218. @ 8,47 SAY WEEK
219. SET COLOR TO W+/B,N/W
220. @ 11,19 GET ACTIVITY PICTURE "9999"
221. @ 11,34 GET TASK PICTURE "999"
222. @ 11,45 GET TIME PICTURE "99.9"
223. CLEAR GETS
224. RETURN
225. *!*************************************************
226. *!
227. *!      PROCEDURE: EDITREC
228. *!
229. *!      CALLED BY: EDITING  (PROCEDURE IN COSTS.PRG)
230. *.
231. *!*************************************************
232. PROCEDURE EDITREC
233. @ 6,29 SAY NAME
234. @ 8,47 SAY WEEK
235. @ 11,19 GET ACTIVITY PICTURE "9999"
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
236. @ 11,34 GET TASK PICTURE "999"
237. @ 11,45 GET TIME PICTURE "99.9"
238. READ
239. RETURN
240. *!*************************************************
241. *!
242. *!       PROCEDURE: BLANKREC
243. *!
244. *!*************************************************
245. PROCEDURE BLANKREC
246. MINITIALS = SPACE( 2 )
247. MWEEK = SPACE(8)
248. MACTIVITY = 0
249. MTASK = 0
250. MTIME = 00.0
251. RETURN
252. *!*************************************************
253. *!
254. *!       PROCEDURE: EDITING
255. *!
256. *!       CALLED BY: COSTS.PRG
257. *!                : SEARCH   (PROCEDURE IN COSTS.PRG)
258. *!
259. *!           CALLS: DISPFORM (PROCEDURE IN COSTS.PRG)
260. *!                : DISPREC  (PROCEDURE IN COSTS.PRG)
261. *!                : BETWEEN()(FUNCTION)
262. *!                : SEARCH   (PROCEDURE IN COSTS.PRG)
263. *!                : EDITREC  (PROCEDURE IN COSTS.PRG)
264. *!
265. *!*************************************************
266. PROCEDURE EDITING
267. CCOUNTER=0
268. * ---DISPLAY SCREEN FORMAT.
269. DO DISPFORM
270. * ---MAIN EXECUTION LOOP.
271. DO WHILE .T.
272.    * ---DISPLAY RECORD.
273.    DO DISPREC
274.    MRECORD=RECNO()
275.    IF MRECORD>RECCOUNT()
276.    MRECORD=RECCOUNT()
277.    ENDIF
278.    MNAME=NAME
279.    MWEEK=WEEK
280.    SUM TIME FOR NAME=MNAME .AND. WEEK=MWEEK TO MTOTAL
281.    GOTO MRECORD
282.    @ 13,16 SAY "TOTAL WEEKLY ACCUMULATED HOURS - "
283.    @ 13,49 SAY MTOTAL PICTURE "99.9"
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
284.    * ---DISPLAY SIMPLE MENU.
285.    CHOICE = " "
286.    SET COLOR TO GR+/B,N/W
287.    @ 19,2 SAY "SELECT:  EDIT  DELETE  NEXT-PREV-TOP-
            BOTTOM  RECORD  SEARCH QUIT";
288.       GET CHOICE PICTURE "!" VALID(CHOICE $
            "EDNPTBRSQ")
289.    READ
290.    DO CASE
291.    CASE CHOICE ='R'
292.       NUMBER=0
293.       DO WHILE .T.
294.          SET CONSOLE ON
295.          @22,20 SAY''
296.          INPUT '                INPUT RECORD NUMBER TO
                GO TO ' TO NUMBER PICTURE 9999
297.          @ 22,0 CLEAR
298.          SET CONSOLE OFF
299.          IF BETWEEN(NUMBER,1,RECCOUNT())
300.             GO NUMBER
301.             EXIT
302.          ELSE
303.             @22,10 SAY 'CHOOSE A RECORD NUMBER
                  BETWEEN 1 AND'+ALLTRIM(STR(RECCOUNT()))
304.             LOOP
305.          ENDIF
306.       ENDDO
307.    CASE CHOICE ='S'
308.       DO SEARCH
309.       EXIT
310.    CASE CHOICE ='Q'
311.       IF CCOUNTER>0
312.         SET COLOR TO R*/B+
313.         @22,20 SAY 'DELETING RECORDS - PLEASE WAIT'
314.         PACK
315.         @22,1 CLEAR
316.         SET COLOR TO GR+/B,N/W
317.       ENDIF
318.       SET FILTER TO
319.       EXIT
320.    CASE CHOICE ='E'
321.       * ---EDIT RECORD.
322.       DO EDITREC
323.    CASE CHOICE ='D'
324.       * ---DELETE RECORD.
325.       CCOUNTER=CCOUNTER+1
326.       IF .NOT. DELETED()
327.          DELETE
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
328.        ELSE
329.           RECALL
330.        ENDIF
331.     CASE CHOICE ='N'
332.        * ---NEXT RECORD.
333.        IF RECNO()=RECCOUNT() .OR. EOF()
334.           GOTO BOTTOM
335.        ELSE
336.           SKIP
337.        ENDIF
338.     CASE CHOICE ='P'
339.        * ---PREVIOUS RECORD.
340.        SKIP -1
341.        IF BOF()
342.           GOTO TOP
343.        ENDIF
344.     CASE CHOICE ='T'
345.        * ---TOP RECORD.
346.        GOTO TOP
347.     CASE CHOICE ='B'
348.        * ---BOTTOM RECORD.
349.        GOTO BOTTOM
350.     ENDCASE
351. ENDDO
352. RETURN
353. *!*************************************************
354. *!
355. *!       PROCEDURE: REPLREC
356. *!
357. *!       CALLED BY: ADDREC    (PROCEDURE IN COSTS.PRG)
358. *!
359. *!*************************************************
360. PROCEDURE REPLREC
361. REPLACE  NAME WITH MNAME
362. REPLACE WEEK WITH MWEEK
363. REPLACE ACTIVITY WITH MACTIVITY
364. REPLACE TASK WITH MTASK
365. REPLACE TIME WITH MTIME
366. REPLACE LNAME WITH MLASTNAME
367. REPLACE HRPAY WITH MSALARY/(52*40)
368. RETURN
369. *!*************************************************
370. *!
371. *!       PROCEDURE: WEEKLY
372. *!
373. *!       CALLED BY: COSTS.PRG
374. *!
375. *!           CALLS: SUMM1     (PROCEDURE IN COSTS.PRG)
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
376. *!                : GETADATE (PROCEDURE IN COSTS.PRG)
377. *!                : SUMM     (PROCEDURE IN COSTS.PRG)
378. *!
379. *!*************************************************
380. PROCEDURE WEEKLY
381. DO SUMM1
382. DO GETADATE
383. IF MONTH(MWEEK)>0
384.    CLEAR
385.    @12,15 SAY 'PLEASE WAIT - PREPARING WEEKLY REPORT'
386.    DO SUMM
387.    SELECT 3
388.    GO TOP
389.    REPORT FORMAT COSTS1.FRX TO PRINTER OFF
390.    SELECT 1
391. ENDIF
392. CLEAR
393. RETURN
394. *!*************************************************
395. *!
396. *!      PROCEDURE: INDIVIDUAL
397. *!
398. *!      CALLED BY: COSTS.PRG
399. *!
400. *!          CALLS: SUMM1    (PROCEDURE IN COSTS.PRG)
401. *!               : GETADATE (PROCEDURE IN COSTS.PRG)
402. *!               : PROJNAME (PROCEDURE IN COSTS.PRG)
403. *!
404. *!           USES: TEMP3.DBF
405. *!               : TEMP6.DBF
406. *!               : TEMP8.DBF
407. *!               : STAFF.DBF
408. *!               : COSTS.DBF
409. *!
410. *!*************************************************
411. PROCEDURE INDIVIDUAL
412. DO SUMM1
413. DO GETADATE
414. IF MONTH(MWEEK)>0
415.    CLEAR
416.    @12,15 SAY 'PLEASE WAIT - PREPARING INDIVIDUAL
             REPORT'
417.    DO PROJNAME
418.    SELECT 1
419.    SORT TO TEMP3.DBF ON COSTS->WEEK,COSTS->LNAME
420.    ZAP
421.    APPEND FROM TEMP3.DBF
422.    DELETE FILE TEMP3.DBF
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
423.     SET RELATION TO STR(COSTS->ACTIVITY,4) INTO H
             ADDITIVE
424.     SET RELATION TO STR(COSTS->ACTIVITY,4) INTO I
             ADDITIVE
425.     REPORT FORMAT COSTS.FRX TO PRINTER FOR WEEK=MWEEK
426.     CLOSE DATABASE
427.     DELETE FILE TEMP6.DBF
428.     DELETE FILE TEMP8.DBF
429.     SELECT 2
430.     USE STAFF
431.     SELECT 1
432.     USE COSTS
433.     GO TOP
434. ENDIF
435. CLEAR
436. RETURN
437. *!*************************************************
438. *!
439. *!      PROCEDURE: PROJNAME
440. *!
441. *!      CALLED BY: INDIVIDUAL(PROCEDURE IN COSTS.PRG)
442. *!
443. *!           USES: CONTR.DBF
444. *!               : TEMP6.DBF
445. *!               : PROJLIST.DBF
446. *!               : TEMP8.DBF
447. *!               : NONPROD.DBF
448. *!
449. *!        INDEXES: PROJ.IDX
450. *!               : CONTR.IDX
451. *!
452. *!*************************************************
453. PROCEDURE PROJNAME
454. IF MCOUNT=0
455.     SELECT 10
456.     USE CONTR
457.     COPY TO TEMP6.DBF FIELDS CONTR_NO,PROJ_NO1,P_DESC1
458.     USE
459.     SELECT 8
460.     USE PROJLIST
461.     COPY TO TEMP8.DBF FIELDS PROJ_NO1,P_DESC1
462.     USE TEMP8
463.     INDEX ON PROJ_NO1 TO PROJ
464.     SELECT 9
465.     USE TEMP6
466.     INDEX ON CONTR_NO TO CONTR
467.     APPEND FROM NONPROD
468.     MCOUNT=1
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
469. ENDIF
470. RETURN
471. *!*****************************************************
472. *!
473. *!       PROCEDURE: ACTSUM
474. *!
475. *!       CALLED BY: COSTS.PRG
476. *!
477. *!           CALLS: SUMM1    (PROCEDURE IN COSTS.PRG)
478. *!                : GETDATES (PROCEDURE IN COSTS.PRG)
479. *!
480. *!            USES: COSTS.DBF
481. *!                : TEMP4.DBF
482. *!                : TEMP5.DBF
483. *!                : CONTR.DBF
484. *!                : TEMP6.DBF
485. *!                : PROJLIST.DBF
486. *!                : TEMP8.DBF
487. *!                : STAFF.DBF
488. *!
489. *!         INDEXES: PROJ.IDX
490. *!                : CONTR.IDX
491. *!
492. *!*****************************************************
493. PROCEDURE ACTSUM
494. DO SUMM1
495. DO GETDATES
496. IF EMPTY(MAXTIME) .OR. EMPTY(MINTIME)
497.    RETURN
498. ENDIF
499. @12,15 SAY 'PLEASE WAIT - PREPARING ACTIVITY REPORT'
500. CLOSE DATABASE
501. SELECT 1
502. USE COSTS
503. SORT TO TEMP4.DBF ON COSTS->ACTIVITY,COSTS->TASK FOR
         COSTS->ACTIVITY < 6000 .AND. MINTIME<=COSTS->WEEK
         .AND. MAXTIME>=COSTS->WEEK
504. SORT TO TEMP5.DBF ON COSTS->ACTIVITY,COSTS->TASK FOR
         COSTS->ACTIVITY > 5999 .AND. MINTIME<=COSTS->WEEK
         .AND. MAXTIME>=COSTS->WEEK
505. SELECT 10
506. USE CONTR
507. COPY TO TEMP6.DBF FIELDS CONTR_NO,PROJ_NO1,P_DESC1
508. USE
509. SELECT 8
510. USE PROJLIST
511. COPY TO TEMP8.DBF FIELDS PROJ_NO1,P_DESC1
512. USE TEMP8
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
513. INDEX ON PROJ_NO1 TO PROJ
514. SELECT 9
515. USE TEMP6
516. INDEX ON CONTR_NO TO CONTR
517. SELECT 7
518. USE TEMP5
519. SUM TEMP5->TIME TO INDTIME
520. SUM (TEMP5->HRPAY*TEMP5->TIME) TO INDPAY
521. SELECT 6
522. USE TEMP4
523. SUM TEMP4->TIME TO DIRTIME
524. SUM (TEMP4->TIME*TEMP4->HRPAY) TO DIRPAY
525. SET RELATION TO STR(TEMP4->ACTIVITY,4) INTO H
         ADDITIVE
526. SET RELATION TO STR(TEMP4->ACTIVITY,4) INTO I
         ADDITIVE
527. REPORT FORMAT DIRECT.FRX TO PRINTER
528. SELECT 7
529. REPORT FORMAT NODIRECT.FRX TO PRINTER NOEJECT
530. CLOSE DATABASE
531. DELETE FILE TEMP4.DBF
532. DELETE FILE TEMP5.DBF
533. DELETE FILE TEMP6.DBF
534. DELETE FILE TEMP8.DBF
535. SELECT 2
536. USE STAFF
537. SELECT 1
538. USE COSTS
539. CLEAR
540. RETURN
541. *!*************************************************
542. *!
543. *!       PROCEDURE: TASKS
544. *!
545. *!       CALLED BY: COSTS.PRG
546. *!
547. *!           CALLS: SUMM1     (PROCEDURE IN COSTS.PRG)
548. *!                : GETDATES  (PROCEDURE IN COSTS.PRG)
549. *!
550. *!            USES: COSTS.DBF
551. *!                : TASK.DBF
552. *!
553. *!*************************************************
554. PROCEDURE TASKS
555. DO SUMM1
556. DO GETDATES
557. IF EMPTY(MINTIME) .OR. EMPTY(MAXTIME)
558.    RETURN
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
559. ENDIF
560. @12,15 SAY 'PLEASE WAIT - PREPARING REPORT'
561. @14,15 SAY 'THE TASKS REPORT MAY TAKE SEVERAL
           MINUTES'
562. SELECT 1
563. USE COSTS
564. SELECT 3
565. USE TASK
566. GO TOP
567. PUBLIC MTTIME
568. PUBLIC MTPAY
569. DO WHILE .NOT. EOF()
570.    MTASKS=TASKS
571.    SELECT 1
572.    SUM COSTS->TIME FOR TASK->TASKS=COSTS->TASK .AND.
           MINTIME<=COSTS->WEEK .AND. MAXTIME>=
             COSTS->WEEK TO MTTIME
573.    SUM (COSTS->HRPAY*COSTS->TIME) FOR TASK->TASKS =
           COSTS->TASK .AND. COSTS->WEEK>=MINTIME .AND.
             COSTS->WEEK<=MAXTIME TO MTPAY
574.    SELECT 3
575.    REPLACE TTIME WITH MTTIME
576.    REPLACE TPAY WITH MTPAY
577.    SKIP
578. ENDDO
579. SUM TASK->TPAY TO MTPAY
580. SUM TASK->TTIME TO MTTIME
581. REPORT FORMAT TASKS.FRX TO PRINTER NOEJECT
582. USE
583. SELECT 1
584. CLEAR
585. RETURN
586. *!*************************************************
587. *!
588. *!       PROCEDURE: CONTRACT
589. *!
590. *!       CALLED BY: COSTS.PRG
591. *!
592. *!           CALLS: SUMM1     (PROCEDURE IN COSTS.PRG)
593. *!                : GETDATES (PROCEDURE IN COSTS.PRG)
594. *!
595. *!            USES: CONTR.DBF
596. *!                : COSTS.DBF
597. *!                : TEMP9.DBF
598. *!                : TASK.DBF
599. *!                : STAFF.DBF
600. *!
601. *!         INDEXES: CONTR.IDX
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
602. *!                : TASKS.IDX
603. *!
604. *!*************************************************
605. PROCEDURE CONTRACT
606. DO SUMM1
607. DO GETDATES
608. IF EMPTY(MINTIME) .OR. EMPTY(MAXTIME)
609.    RETURN
610. ENDIF
611. @12,15 SAY 'PLEASE WAIT - PREPARING REPORT'
612. PUBLIC MCONTR_NO
613. PUBLIC MPROJ_NO1
614. PUBLIC PRETIME, POSTTIME, CONTIME, PRECOST, CONCOST,
         POSTCOST
615. STORE '     ' TO MCONTR_NO
616. STORE '     ' TO MPROJ_NO1
617. CLEAR
618. DO WHILE .T.
619.    @3,10 SAY 'SPECIFY CONTRACT NUMBER: 'GET MCONTR_NO
            PICTURE '9999'
620.    @4,10 SAY '(RETURN TO GO TO MAIN PRINT MENU)'
621.    READ
622.    IF VAL(MCONTR_NO)>0
623.    ELSE
624.       CLEAR
625.       RETURN
626.    ENDIF
627.    SELECT 3
628.    USE CONTR
629.    INDEX ON CONTR_NO TO CONTR
630.    GO TOP
631.    SEEK MCONTR_NO+" "
632.    IF EOF()
633.       CLEAR
634.       @12,12 SAY MCONTR_NO+" IS NOT IN THE CONTRACT
                  DATABASE"
635.       STORE '     ' TO MCONTR_NO
636.       LOOP
637.    ELSE
638.       EXIT
639.    ENDIF
640. ENDDO
641. CLEAR
642. @12,15 SAY 'PLEASE WAIT - PREPARING CONTRACT SUMMARY
          REPORT'
643. MPROJ_NO1=PROJ_NO1
644. SELECT 1
645. USE COSTS
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
646. SORT TO TEMP9.DBF ON COSTS->TASK FOR COSTS->ACTIVITY
         = VAL(MCONTR_NO) .OR. COSTS->ACTIVITY =
           VAL(MPROJ_NO1)
647. SELECT 4
648. USE TASK
649. INDEX ON TASKS TO TASKS
650. SELECT 5
651. USE TEMP9
652. GO TOP
653. DELETE ALL FOR TEMP9->WEEK<MINTIME .OR.
         TEMP9->WEEK>MAXTIME
654. PACK
655. SUM TEMP9->TIME FOR TEMP9->TASK<150 TO PRETIME
656. SUM TEMP9->TIME FOR TEMP9->TASK>149 .AND.
         TEMP9->TASK<210 TO CONTIME
657. SUM TEMP9->TIME FOR TEMP9->TASK>209 TO POSTTIME
658. SUM TEMP9->TIME * TEMP9->HRPAY FOR TEMP9->TASK<150 TO
         PRECOST
659. SUM TEMP9->TIME * TEMP9->HRPAY FOR TEMP9->TASK>149
         .AND. TEMP9->TASK<210 TO CONCOST
660. SUM TEMP9->TIME * TEMP9->HRPAY FOR TEMP9->TASK>209 TO
         POSTCOST
661. SET RELATION TO TEMP9->TASK INTO D ADDITIVE
662. REPORT FORMAT CONTRACT.FRX TO PRINT NOFJECT
663. RELEASE MPROJ_NO1
664. RELEASE PRETIME, POSTTIME, CONTIME, PRECOST, CONCOST,
         POSTCOST
665. SET RELATION TO
666. SELECT 5
667. USE
668. DELETE FILE TEMP9.DBF
669. CLOSE DATABASE
670. SELECT 2
671. USE STAFF
672. SELECT 1
673. USE COSTS
674. CLEAR
675. RETURN
676. *!*************************************************
677. *!
678. *!    PROCEDURE: GETADATE
679. *!
680. *!    CALLED BY: WEEKLY       (PROCEDURE IN COSTS.PRG)
681. *!             : INDIVIDUAL   (PROCEDURE IN COSTS.PRG)
682. *!             : SEARCH       (PROCEDURE IN COSTS.PRG)
683. *!
684. *!*************************************************
685. PROCEDURE GETADATE
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
686. @3,1 SAY'SELECT REPORT DATE'
687. SET MESSAGE TO 1
688. @23,5 SAY 'PRESS ESCAPE TO RETURN'
689. @24,5 SAY ' TO PRINT MENU'
690. ACTIVATE POPUP DATES
691. MMWEEK=PROMPT()
692. MWEEK=CTOD(MMWEEK)
693. RETURN
694. *!*************************************************
695. *!      PROCEDURE: GETDATES
696. *!
697. *!      CALLED BY: ACTSUM   (PROCEDURE IN COSTS.PRG)
698. *!               : TASKS    (PROCEDURE IN COSTS.PRG)
699. *!               : CONTRACT (PROCEDURE IN COSTS.PRG)
700. *!
701. *!*************************************************
702. PROCEDURE GETDATES
703. CLEAR
704. @3,1 SAY'SELECT REPORT STARTING DATE'
705. @22,5 SAY 'PRESS ESCAPE TO RETURN'
706. @23,5 SAY ' TO PRINT MENU'
707. ACTIVATE POPUP DATES
708. PPP=PROMPT()
709. MINTIME=CTOD(PROMPT())
710. CLEAR
711. IF .NOT. EMPTY(MINTIME)
712.    DO WHILE .T.
713.       @3,1  SAY'SELECT REPORT ENDING DATE'
714.       @4,1  SAY 'ON OR AFTER '+ PPP
715.       @23,5 SAY 'PRESS ESCAPE TO RETURN'
716.       @24,5 SAY ' TO PRINT MENU'
717.       ACTIVATE POPUP DATES
718.       MAXTIME=CTOD(PROMPT())
719.       IF EMPTY(MAXTIME)
720.          CLEAR
721.          RETURN
722.       ENDIF
723.       IF MAXTIME>=MINTIME
724.          EXIT
725.       ELSE
726.          @ 10,1 SAY 'NOTE - ENDING TIME MUST BE'
727.          @ 11,1 SAY'        > OR = TO ' +PPP
728.          STORE 0 TO N
729.          SET CONSOLE ON
730.          DO WHILE N<4
731.             ?CHR(7)
732.             STORE N+1 TO N
733.          ENDDO
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
734.           SET CONSOLE OFF
735.           LOOP
736.         ENDIF
737.      ENDDO
738.      CLEAR
739. ENDIF
740. RETURN
741. *!*****************************************************
742. *!
743. *!       PROCEDURE: SEARCH
744. *!
745. *!       CALLED BY: EDITING    (PROCEDURE IN COSTS.PRG)
746. *!
747. *!           CALLS: INTIALIZE (PROCEDURE IN COSTS.PRG)
748. *!                : EMPLOYEE  (PROCEDURE IN COSTS.PRG)
749. *!                : BETWEEN() (FUNCTION)
750. *!                : SUMM1     (PROCEDURE IN COSTS.PRG)
751. *!                : GETADATE  (PROCEDURE IN COSTS.PRG)
752. *!                : ACTIVE    (PROCEDURE IN COSTS.PRG)
753. *!                : TASKNO    (PROCEDURE IN COSTS.PRG)
754. *!                : TIME      (PROCEDURE IN COSTS.PRG)
755. *!                : EDITING   (PROCEDURE IN COSTS.PRG)
756. *!
757. *!            USES: COSTS.DBF
758. *!
759. *!*****************************************************
760. PROCEDURE SEARCH
761. MCOUNTER=0
762. CLEAR
763. SET CONFIRM ON
764. SET EXACT OFF
765. PUBLIC LACTIVITY, ULACTIVITY, LTASK, ULTASK, LTIME,
          ULTIME, LWEEK, ULWEEK,LONAME,ULONAME
766. PUBLIC MCOUNT
767. DEFINE POPUP SEARCH FROM 7,35 COLOR SCHEME 15
768. DEFINE BAR 1 OF SEARCH PROMPT '  CHOSE SELECTION
           ITEM(S)  ' SKIP
769. DEFINE BAR 2 OF SEARCH PROMPT '  ' SKIP
770. DEFINE BAR 3 OF SEARCH PROMPT '\<QUIT'
771. DEFINE BAR 4 OF SEARCH PROMPT '\<NAME'
772. DEFINE BAR 5 OF SEARCH PROMPT '\<WEEK'
773. DEFINE BAR 6 OF SEARCH PROMPT '\<ACTIVITY'
774. DEFINE BAR 7 OF SEARCH PROMPT '\<TASK'
775. DEFINE BAR 8 OF SEARCH PROMPT 'T\<IME'
776. DEFINE BAR 9 OF SEARCH PROMPT '\<EDIT SEARCHED
           RECORDS'
777. DEFINE BAR 10 OF SEARCH PROMPT '\<REINTIALIZE SEARCH
           VARIABLES'
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
778. DEFINE BAR 11 OF SEARCH PROMPT '\<PRINT SEARCHED
          RECORDS'
779. ON SELECTION POPUP SEARCH DEACTIVATE POPUP
780. ULINE = REPLICATE ('_',80)
781. USE COSTS
782. SET COLOR TO W/B+
783. CLEAR
784. @ 2,25 SAY 'SEARCH - MAIN MENU'
785. @ 2,50 SAY DTOC(DATE()) + '    ' + TIME()
786. @ 3,0 SAY ULINE
787. SET COLOR TO GR+/B+
788. DO INTIALIZE
789. DO WHILE .T.
790.    SET COLOR TO R*/B+
791.    @ 5,0 CLEAR TO 7,70
792.    @23,18 SAY 'COUNTING RECORDS - PLEASE WAIT'
793.    COUNT FOR COSTS->LNAME>" " TO MCOUNT
794.    SET COLOR TO GR+/B+
795.    @23,0 CLEAR
796.    @ 5,36 SAY 'HIGHLIGHT CHOICE & PRESS RETURN '
797.    @ 6,1 SAY 'THERE ARE '+LTRIM(STR(MCOUNT))+'
             RECORDS MEETING'
798.    @ 7,1 SAY '  THE FOLLOWING SEARCH CRITERA'
799.    ACTIVATE POPUP SEARCH
800.    CHOICE=PROMPT()
801.    DO CASE
802.    CASE CHOICE = "NAME"
803.       @1,0 CLEAR TO 4,79
804.       @1,35 CLEAR TO 24,79
805.       DO EMPLOYEE
806.       SELECT 1
807.       @20,0 CLEAR
808.       LONAME=PROMPT()
809.       @1,30 CLEAR TO 24,78
810.       @ 2,25 SAY 'SEARCH - MAIN MENU'
811.       @ 2,50 SAY DTOC(DATE()) + '    ' + TIME()
812.       @ 3,0 SAY ULINE
813.       SET COLOR TO GR+/B+
814.       @9,2 SAY 'NAME  - '+LONAME
815.       ULONAME=LONAME
816.       SET FILTER TO BETWEEN(COSTS->ACTIVITY,
                LACTIVITY, ULACTIVITY) .AND.
                BETWEEN(COSTS->TASK, LTASK, ULTASK).AND.
                BETWEEN(COSTS->TIME,LTIME,ULTIME) .AND.
                BETWEEN(COSTS->NAME,LONAME,ULONAME) .AND.
                BETWEEN(COSTS->WEEK,LWEEK,ULWEEK)
817.    CASE CHOICE = "WEEK"
818.       @1,0 CLEAR TO 4,79
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
819.        @1,35 CLEAR TO 24,79
820.        DO SUMM1
821.        SET COLOR TO W/B+
822.        DO GETADATE
823.        SELECT 1
824.        @20,0 CLEAR
825.        LWEEK=MWEEK
826.        @1,30 CLEAR TO 24,78
827.        @ 2,25 SAY 'SEARCH - MAIN MENU'
828.        @ 2,50 SAY DTOC(DATE()) + '    ' + TIME()
829.        @ 3,0 SAY ULINE
830.        SET COLOR TO GR+/B+
831.        @10,2 SAY 'WEEK - '
832.        @10,9 SAY LWEEK
833.        ULWEEK=LWEEK
834.        SET FILTER TO BETWEEN(COSTS->ACTIVITY,
                 LACTIVITY, ULACTIVITY) .AND.
                 BETWEEN(COSTS->TASK, LTASK, ULTASK).AND.
                 BETWEEN(COSTS->TIME,LTIME,ULTIME) .AND.
                 BETWEEN(COSTS->NAME,LONAME,ULONAME) .AND.
                 BETWEEN(COSTS->WEEK,LWEEK,ULWEEK)
835.     CASE CHOICE = "ACTIVITY"
836.        DO ACTIVE
837.     CASE CHOICE = "TASK"
838.        DO TASKNO
839.     CASE CHOICE = "TIME"
840.        DO TIME
841.     CASE CHOICE = "REINTIALIZE SEARCH VARIABLES"
842.        DO INTIALIZE
843.     CASE CHOICE = "QUIT"
844.        CLEAR
845.        GO TOP
846.        SET CONFIRM OFF
847.        SET FILTER TO
848.        RELEASE LACTIVITY, ULACTIVITY, LTASK, ULTASK,
             LTIME, ULTIME, LWEEK, ULWEEK, LONAME, ULONAME
849.        RETURN
850.     CASE CHOICE = "PRINT SEARCHED RECORDS"
851.        @5,0 CLEAR TO 8,70
852.        @22,20 SAY "PLEASE WAIT - PREPARING REPORT"
853.        REPORT FORMAT SEARCH.FRX TO PRINT NOEJECT
854.        @22,19 CLEAR TO 22,78
855.     CASE CHOICE = "EDIT SEARCHED RECORDS"
856.        SET CONFIRM OFF
857.        GO TOP
858.        DO EDITING
859.        CLEAR
860.        EXIT
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
861.     ENDCASE
862.  ENDDO
863.  RETURN
864.  *!*************************************************
865.  *!
866.  *!       PROCEDURE: SUMM
867.  *!
868.  *!       CALLED BY: WEEKLY    (PROCEDURE IN COSTS.PRG)
869.  *!
870.  *!            USES: COSTS.DBF
871.  *!                : TEMP.DBF
872.  *!                : STAFF.DBF
873.  *!
874.  *!*************************************************
875.  PROCEDURE SUMM
876.  SELECT 3
877.  USE
878.  SELECT 1
879.  USE COSTS
880.  GO TOP
881.  COPY STRUCTURE TO TEMP FIELDS NAME,TIME
882.  GO BOTTOM
883.  SELECT 2
884.  USE
885.  SELECT 3
886.  USE TEMP
887.  ZAP
888.  APPEND FROM STAFF
889.  SELECT 2
890.  USE STAFF
891.  SELECT 3
892.  GO TOP
893.  DO WHILE .NOT. EOF()
894.     SELECT 1
895.     SUM COSTS->TIME FOR TEMP->NAME=COSTS->NAME .AND.
           WEEK=MWEEK TO MTIME
896.     SELECT 3
897.     REPLACE TIME WITH MTIME
898.     SKIP
899.  ENDDO
900.  SELECT 1
901.  GO TOP
902.  RETURN
903.  *!*************************************************
904.  *!
905.  *!       PROCEDURE: ACTIVE
906.  *!
907.  *!       CALLED BY: SEARCH    (PROCEDURE IN COSTS.PRG)
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
908. *!
909. *!          CALLS: BETWEEN() (FUNCTION)
910. *!
911. *!*************************************************
912. PROCEDURE ACTIVE
913. SET COLOR TO GR+/B+
914. @5,0 CLEAR TO 8,70
915. LACTIVITY=0
916. @21,21 SAY "ENTER ACTIVITY NUMBER THEN PRESS RETURN "
917. @ 23,21 SAY " ACTIVITY NUMBER ? " GET LACTIVITY
             PICTURE "9999"
918. READ
919. @21,0 CLEAR
920. @11,2 SAY 'ACTIVITY NUMBER - '+LTRIM(STR(LACTIVITY))
          +'        '
921. ULACTIVITY=LACTIVITY
922.        SET FILTER TO BETWEEN(COSTS->ACTIVITY,
                LACTIVITY, ULACTIVITY) .AND.
                BETWEEN(COSTS->TASK, LTASK, ULTASK).AND.
                BETWEEN(COSTS->TIME,LTIME,ULTIME) .AND.
                BETWEEN(COSTS->NAME,LONAME,ULONAME) .AND.
                BETWEEN(COSTS->WEEK,LWEEK,ULWEEK)
923. GO TOP
924. RETURN
925. *!*************************************************
926. *!
927. *!       PROCEDURE: BSEARCH
928. *!
929. *!*************************************************
930. PROCEDURE BSEARCH
931. SELE 1
932. GO TOP
933. SET COLOR TO R*/B+
934. @ 22,12 SAY 'C O M P U T E R  W O R K I N G -
             S T A N D B Y'
935. EDIT
936. RETURN
937. *!*************************************************
938. *!
939. *!       PROCEDURE: TASKNO
940. *!
941. *!       CALLED BY: SEARCH   (PROCEDURE IN COSTS.PRG)
942. *!
943. *!           CALLS: BETWEEN() (FUNCTION)
944. *!
945. *!*************************************************
946. PROCEDURE TASKNO
947. SET COLOR TO GR+/B+
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
948. @5,0 CLEAR TO 8,70
949. LTASK=0
950. @ 21,21 SAY " ENTER TASK NUMBER THEN PRESS RETURN "
951. @ 23,21 SAY " TASK NUMBER ? " GET LTASK PICTURE "999"
952. READ
953. @21,0 CLEAR
954. @12,2 SAY 'TASK NUMBER - '+LTRIM(STR(LTASK))+'      '
955. ULTASK=LTASK
956. SET FILTER TO BETWEEN(COSTS->ACTIVITY,
         LACTIVITY, ULACTIVITY) .AND.
         BETWEEN(COSTS->TASK, LTASK, ULTASK).AND.
         BETWEEN(COSTS->TIME,LTIME,ULTIME) .AND.
         BETWEEN(COSTS->NAME,LONAME,ULONAME) .AND.
         BETWEEN(COSTS->WEEK,LWEEK,ULWEEK)
957. RETURN
958. *!*************************************************
959. *!      PROCEDURE: TIME
960. *!
961. *!      CALLED BY: SEARCH   (PROCEDURE IN COSTS.PRG)
962. *!
963. *!          CALLS: BETWEEN() (FUNCTION)
964. *!
965. *!*************************************************
966. PROCEDURE TIME
967. SET COLOR TO GR+/B+
968. @6,10 CLEAR TO 6,70
969. LTIME=0
970. @ 21,21 SAY " ENTER TIME NUMBER THEN PRESS RETURN "
971. @ 23,21 SAY " TIME TO SEARCH FOR? " GET LTIME
             PICTURE "99.9"
972. READ
973. @21,0 CLEAR
974. @13,2 SAY 'TIME - '+STR(LTIME,4,1)+ '      '
975. ULTIME=LTIME
976. SET FILTER TO BETWEEN(COSTS->ACTIVITY,
         LACTIVITY, ULACTIVITY) .AND.
         BETWEEN(COSTS->TASK, LTASK, ULTASK).AND.
         BETWEEN(COSTS->TIME,LTIME,ULTIME) .AND.
         BETWEEN(COSTS->NAME,LONAME,ULONAME) .AND.
         BETWEEN(COSTS->WEEK,LWEEK,ULWEEK)
977. RETURN
978. *!*************************************************
979. *!
980. *!      PROCEDURE: INTIALIZE
981. *!
982. *!      CALLED BY: SEARCH   (PROCEDURE IN COSTS.PRG)
983. *!
984. *!*************************************************
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
985. PROCEDURE INTIALIZE
986. LACTIVITY=0
987. ULACTIVITY=9999
988. LTASK=0
989. ULTASK=999
990. LTIME=0
991. ULTIME=99
992. LWEEK=CTOD("00/00/00")
993. ULWEEK=CTOD("01/12/99")
994. LONAME="A"
995. ULONAME="Z"
996. SET FILTER TO
997. @9,2 SAY 'NAME - ALL                                    '
998. @10,2 SAY 'WEEK - ALL                                   '
999. @11,2 SAY 'ACTIVITY NUMBER - ALL    '
1000. @12,2 SAY 'TASK NUMBER - ALL    '
1001. @13,2 SAY 'TIME - ALL     '
1002. RETURN
1003. GO TOP
1004. SEEK MPROJ_NU
1005. IF .NOT. FOUND() .OR. EOF()
1006.    CLEAR
1007.    @ 5,23 SAY " NOT FOUND "
1008.    WAIT
1009.    CLEAR
1010.    CLOSE DATA
1011.    RETURN
1012. ENDIF
1013. @ 6,7 SAY "SYSTEM NUMBER " GET SYS_NO
1014. @ 6,31 SAY "PROJECT NUMBER" GET PROJ_NO
1015. @ 8,7 SAY " DATE CLOSED OUT " GET C_30_DATE
1016. @ 8,38 SAY "AMOUNT" GET AMOUNT
1017. @ 10,7 SAY "PROJECT NAME" GET NAME
1018. RETURN
1019. *!*************************************************
1020. *!
1021. *!    PROCEDURE: SUMM1
1022. *!
1023. *!    CALLED BY: WEEKLY     (PROCEDURE IN COSTS.PRG)
1024. *!             : INDIVIDUAL (PROCEDURE IN COSTS.PRG)
1025. *!             : ACTSUM     (PROCEDURE IN COSTS.PRG)
1026. *!             : TASKS      (PROCEDURE IN COSTS.PRG)
1027. *!             : CONTRACT   (PROCEDURE IN COSTS.PRG)
1028. *!             : SEARCH     (PROCEDURE IN COSTS.PRG)
1029. *!
1030. *!         USES: COSTS.DBF
1031. *!             : TEMP1.DBF
1032. *!
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
1033. *!       INDEXES: WEEKLY.IDX
1034. *!
1035. *!*************************************************
1036. PROCEDURE SUMM1
1037. IF MCOUNTER=0
1038.    SELECT 5
1039.    USE
1040.    @22,20 SAY 'PLEASE WAIT - GETTING AVAILABLE
               DATES'
1041.    SELECT 1
1042.    USE COSTS
1043.    GO TOP
1044.    INDEX ON WEEK UNIQUE TO WEEKLY
1045.    COPY TO TEMP1.DBF FIELD WEEK
1046.    CLOSE INDEX
1047.    SELECT 5
1048.    USE TEMP1
1049.    INDEX ON WEEK TO WEEKLY
1050.    SELECT 1
1051.    GO TOP
1052.    @22,0 CLEAR
1053.    MCOUNTER=1
1054.    RETURN
1055. ELSE
1056.    SELECT 5
1057.    USE TEMP1
1058.    INDEX ON WEEK TO WEEKLY
1059. ENDIF
1060. RETURN
1061. *!*************************************************
1062. *!
1063. *!       PROCEDURE: EMPLOYEE
1064. *!
1065. *!       CALLED BY: COSTS.PRG
1066. *!                : SEARCH   (PROCEDURE IN COSTS.PRG)
1067. *!
1068. *!*************************************************
1069. PROCEDURE EMPLOYEE
1070. @ 3,10 SAY 'CHOSE AN EMPLOYEE   '
1071. ACTIVATE POPUP EMPLOYEE
1072. MNAME =PROMPT()
1073. MWEEK=MWEEK1
1074. MLASTNAME=STAFF->LASTNAME
1075. MSALARY=STAFF->SALARY
1076. RETURN
1077. *!*************************************************
1078. *!
1079. *!       PROCEDURE: ADDREC
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
1080. *!
1081. *!      CALLED BY: COSTS.PRG
1082. *!
1083. *!          CALLS: REPLREC (PROCEDURE IN COSTS.PRG)
1084. *!
1085. *!*************************************************
1086. PROCEDURE ADDREC
1087. * ---INITIALIZE MEMVARS.
1088. DO WHILE .T.
1089.    SUM TIME FOR NAME=MNAME .AND. WEEK=MWEEK TO
          MTOTAL
1090.    MACTIVITY = 0
1091.    MTASK = 0
1092.    MTIME = 00.0
1093.    MCHOICE=" "
1094.    @ 19,0
1095.    @ 19,5 SAY "APPENDING RECORD - PRESS {CTRL-W} TO
            EXIT"
1096.    * ---READ INTO MEMVARS.
1097.    SET COLOR TO W+/B,N/W
1098.    @ 3, 15 SAY "THIS WILL BE RECORD NUMBER - "+
               SUBSTR(STR(RECCOUNT()+1000001,7),2)
1099.    *   @ 3,15 SAY ""+ RECCOUNT()+1
1100.    @ 6,29 SAY MNAME
1101.    @ 8,47 SAY MWEEK
1102.    @ 11,19 GET MACTIVITY PICTURE "9999"
1103.    @ 11,34 GET MTASK PICTURE "999"
1104.    @ 11,45 GET MTIME PICTURE "99.9"
1105.    @ 13,16 SAY "TOTAL WEEKLY ACCUMULATED HOURS - "
1106.    @ 13,49 SAY MTOTAL PICTURE "99.9"
1107.    READ
1108.    MTOTAL=MTOTAL+MTIME
1109.    @ 13,49 SAY MTOTAL PICTURE "99.9"
1110.    * ---CONFIRM THAT USER WANTS TO APPEND THIS
            RECORD.
1111.    CHOICE = " "
1112.    SET COLOR TO GR+/B,N/W
1113.    @ 19,0
1114.    @ 19,2 SAY "SELECT:  {A}CCEPT AND CONTINUE
            {I}GNORE   {N}EW EMPLOYEE  {E}ND APPENDING";
1115.       GET CHOICE PICTURE "!" VALID( CHOICE $ "-
               +AINE" )
1116.    READ
1117.    DO CASE
1118.    CASE CHOICE = "A"
1119.       * ---ADD THE NEW RECORD.
1120.       APPEND BLANK
1121.       * ---REPLACE FROM MEMVARS.
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
1122.        DO REPLREC
1123.        LOOP
1124.     CASE CHOICE = "+"
1125.        * ---ADD THE NEW RECORD.
1126.        APPEND BLANK
1127.        * ---REPLACE FROM MEMVARS.
1128.        DO REPLREC
1129.        LOOP
1130.     CASE CHOICE = "I"
1131.        LOOP
1132.     CASE CHOICE = "E"
1133.        IF MACTIVITY>0 .AND. MTIME>0
1134.           APPEND BLANK
1135.           DO REPLREC
1136.        ENDIF
1137.        MCHOICE=CHOICE
1138.        RETURN
1139.     CASE CHOICE = "N"
1140.        IF MACTIVITY>0 .AND. MTIME>0
1141.           APPEND BLANK
1142.           DO REPLREC
1143.        ENDIF
1144.        RETURN
1145.     CASE CHOICE = "-"
1146.        IF MACTIVITY>0 .AND. MTIME>0
1147.           APPEND BLANK
1148.           DO REPLREC
1149.        ENDIF
1150.        RETURN
1151.     ENDCASE
1152. ENDDO
1153. RETURN
1154. *!*************************************************
1155. *!
1156. *!       PROCEDURE: COPYING
1157. *!
1158. *!       CALLED BY: COSTS.PRG
1159. *!
1160. *!           CALLS: ERRPROC (PROCEDURE IN COSTS.PRG)
1161. *!
1162. *!            USES: CONTRACT.DBF
1163. *!                : CONTR.DBF
1164. *!                : PROJLOAD.DBF
1165. *!                : PROJLIST.DBF
1166. *!                : COSTS.DBF
1167. *!
1168. *!*************************************************
1169. PROCEDURE COPYING
```

APPENDIX V. (COSTS.PRG CONTINUED)

```
1170. CLEAR
1171. SET EXCLUSIVE OFF
1172. ON ERROR DO ERRPROC
1173. SELECT 1
1174. USE F:\CONST\CONTRACT\DATA\CONTRACT.DBF NOUPDATE
1175. IF FLOCK()
1176.    @8,20 SAY "PLEASE WAIT"
1177.    @10,15 SAY "COPYING CONTRACT FILE"
1178.    COPY TO CONTR.DBF FIELDS CONTR_NO ,PROJ_NO1,
               P_DESC1
1179.    USE
1180. ENDIF
1181. USE F:\CONST\CONTRACT\DATA\PROJLOAD.DBF NOUPDATE
1182. IF FLOCK()
1183.    @8,20 SAY "PLEASE WAIT"
1184.    @10,15 SAY "COPYING PROJLOAD FILE"
1185.    COPY TO PROJLIST.DBF FIELDS PROJ_NO1,P_DESC1
1186. ENDIF
1187. USE COSTS
1188. SET EXCLUSIVE ON
1189. CLEAR
1190. ON ERROR
1191. RETURN
1192. *!*************************************************
1193. *!
1194. *!       PROCEDURE: ERRPROC
1195. *!
1196. *!       CALLED BY: COPYING (PROCEDURE IN COSTS.PRG)
1197. *!
1198. *!*************************************************
1199. PROCEDURE ERRPROC
1200. RETURN
1201. *: EOF: COSTS.PRG
```

APPENDIX VI. Construction Staff Updating Program

```
1. *!*****************************************************
2. *:         PROGRAM: STAFF.PRG
3. *:  LAST MODIFIED: 09/17/90
4. *:  PROCS & FNCTS: ERROR
5. *:                : OPEN
6. *:                : MENU
7. *:                : STA_APPE
8. *:                : STA_EDIT
9. *:                : STA_REPO
10. *:               : S_EDIT
11. *:               : SAVING
12. *:               : CLOSING
13. *:               : SAYREC
14. *:               : GETKEY
15. *:               : STATLINE
16. *:               : SAYEOF
17. *:               : SAYLINE
18. *:               : GOTOREC
19. *:               : DOGOTO
20. *:               : DOCONT
21. *:               : STA_FORM
22. *:               : STA_SAYS
23. *:               : STA_GETS
24. *:               : STA_STOR
25. *:               : STA_REPL
26. *:               : SALVARIABLES
27. *:               : TOTSALARY
28. *:               : FORM
29. *:               : S_REPL
30. *:               : S_SAYS
31. *:               : S_STOR
32. *:               : S_GETS
33. *:               : ERROR1
34. *:
35. *:          CALLS: ERROR      (PROCEDURE IN STAFF.PRG)
36. *:               : OPEN       (PROCEDURE IN STAFF.PRG)
37. *:               : MENU       (PROCEDURE IN STAFF.PRG)
38. *:               : STA_APPE   (PROCEDURE IN STAFF.PRG)
39. *:               : STA_EDIT   (PROCEDURE IN STAFF.PRG)
40. *:               : STA_REPO   (PROCEDURE IN STAFF.PRG)
41. *:               : S_EDIT     (PROCEDURE IN STAFF.PRG)
42. *:               : SAVING     (PROCEDURE IN STAFF.PRG)
43. *:               : CLOSING    (PROCEDURE IN STAFF.PRG)
44. *:
45. *:           USES: STAFF.DBF
46. *:               : TEMP.DBF
47. *!*****************************************************
48. * ---SET ENVIRONMENT.
49. SET TALK OFF
```

APPENDIX VI. (staff.prg CONTINUED)

```
50. SET STATUS OFF
51. SET HELP OFF
52. SET BELL OFF
53. SET MENUS OFF
54. SET SAFETY OFF
55. SET ESCAPE OFF
56. SET SCOREBOARD OFF
57. * ---OPEN PROCEDURE FILE.
58. SET PROCEDURE TO STAFF
59. ON ERROR DO ERROR WITH MESSAGE()
60. * ---DECLARE GLOBAL MEMORY VARIABLES.
61. PRIVATE PGDN, PGUP, RETURNKEY, DELRECORD, ISEDITED,
        PROMPTBAR, PROMPTROW, MAINCHOICE, MENUCHOICE,
        CHOICE
62. STORE .F. TO PGDN, PGUP, RETURNKEY, DELRECORD,
        ISEDITED, PROMPTBAR, PROMPTROW, MAINCHOICE,
        MENUCHOICE, CHOICE
63. PRIVATE LASTREC, RECNUM,OLDRECNUM, PAGENO, PAGEMAX,
        EXPR, ISVALID
64. STORE .F. TO LASTREC, RECNUM, OLDRECNUM, PAGENO,
        PAGEMAX, EXPR, ISVALID
65. * ---DECLARE USER-DEFINED MEMORY VARIABLES.
66. PRIVATE LASTNAME, FIRSTNAME, NAME, INITIALS, JOBCODE,
        TITLE, SALARY, BSALARY, PBSALARY, LONGEVITY
67. STORE " " TO LASTNAME, FIRSTNAME, NAME, INITIALS,
        JOBCODE, TITLE
68. STORE 0.00 TO SALARY, BSALARY, PBSALARY, LONGEVITY
69. * ---DECLARE FIELD MEMORY VARIABLES.
70. PRIVATE  MLASTNAME, MFIRSTNAME, MINITIALS, MJOBCODE,
        MTITLE, MBSALARY, MPBSALARY, MLONGEVITY
71. STORE " " TO MLASTNAME, MFIRSTNAME,MINITIALS,
        MJOBCODE, MTITLE
72. STORE 0.00 TO MBSALARY, MPBSALARY, MLONGEVITY
73. SET COLOR TO GR+/B,N/W
74. * ---INITIALIZE GLOBAL MEM VARI. AND OPEN FILE(S).
75. DO OPEN
76. MAINCHOICE = "Q"
77. * ---EXECUTE MAIN LOOP.
78. DO WHILE .T.
79.     * ---DISPLAY MAIN MENU AND GET CHOICE.
80.     DO MENU WITH MAINCHOICE
81.     DO CASE
82.     CASE MAINCHOICE $ "Q"+RETURNKEY
83.        SELECT 1
84.        USE STAFF
85.        PACK
86.        * --- DO SORT
87.        SORT ON LASTNAME TO TEMP.DBF
```

APPENDIX VI. (staff.prg CONTINUED)

```
88.         ZAP
89.         APPEND FROM TEMP.DBF
90.         DELETE FILE TEMP.DBF
91.         EXIT
92.      CASE MAINCHOICE = "A"
93.         * ---DO APPEND.
94.         DO STA_APPE
95.      CASE MAINCHOICE = "E"
96.         * ---DO EDIT/VIEW.
97.         ISEDITED = .F.
98.         DO STA_EDIT WITH ISEDITED
99.      CASE MAINCHOICE = "R"
100.         * ---DO REPORT.
101.         DO STA_REPO
102.      CASE MAINCHOICE = "C"
103.         * --DO S_EDIT
104.         DO S_EDIT
105.
106.      ENDCASE
107. ENDDO
108. DO SAVING
109. DO CLOSING
110. * ---CLOSING OPERATIONS.
111. *!*****************************************************
112. *!
113. *!    PROCEDURE: CLOSING
114. *!
115. *!    CALLED BY: STAFF.PRG
116. *!                 : ERROR     (PROCEDURE IN STAFF.PRG)
117. *!
118. *!*****************************************************
119. PROCEDURE CLOSING
120. CLEAR
121. CLOSE DATABASE
122. CLOSE INDEX
123. CLOSE PROCEDURE
124. SET SCOREBOARD ON
125. SET ESCAPE ON
126. SET SAFETY ON
127. SET MENUS ON
128. SET BELL ON
129. SET HELP ON
130. SET STATUS ON
131. SET TALK ON
132. QUIT
133. * RETURN
134. *!*****************************************************
135. *!
```

APPENDIX VI. (staff.prg CONTINUED)

```
136. *!   PROCEDURE: SAVING
137. *!
138. *!   CALLED BY: STAFF.PRG
139. *!
140. *!          CALLS: ERROR1   (PROCEDURE IN STAFF.PRG)
141. *!
142. *!           USES: STAFF.DBF
143. *!
144. *!*************************************************
145. PROCEDURE SAVING
146. CLOSE ALL
147. ON ERROR DO ERROR1 WITH MESSAGE()
148. COPY FILE STAFF.DBF TO F:\CONST\TIME\STAFF.DBF
149. ON ERROR
150. RETURN
151. *!*************************************************
152. *!
153. *!      PROCEDURE: OPEN
154. *!
155. *!      CALLED BY: STAFF.PRG
156. *!
157. *!           USES: STAFF.DBF
158. *!
159. *!*************************************************
160. PROCEDURE OPEN
161. * ---INKEY() CONSTANT VALUES.
162. COPY FILE F:\CONST\TIME\STAFF.DBF TO STAFF.DBF
163. PGDN = CHR(3)
164. PGUP = CHR(18)
165. RETURNKEY = CHR(13)
166. DELRECORD = CHR(7)
167. * ---INITIALIZE GLOBAL VARIABLES.
168. STORE 0 TO LASTREC,OLDRECNUM,RECNUM,MENUCHOICE
169. STORE " " TO CHOICE,EXPR
170. PROMPTROW = 19
171. PROMPTBAR = REPLICATE( CHR( 196 ),80 )
172. * ---OPEN DATABASE FILE.
173. SELECT A
174. USE STAFF
175. IF .NOT. FILE( "STAFF.DBF" )
176.    ? ["STAFF.DBF" NOT FOUND]
177.    WAIT
178.    QUIT
179. ENDIF
180. * ---OPEN CONDITIONS FILE.
181. * ---INITIALIZE DATABASE VARI. FOR CURRENT WORKAREA.
182. RETURN
183. *!*************************************************
```

APPENDIX VI. (staff.prg CONTINUED)

```
184. *!
185. *!       PROCEDURE: MENU
186. *!
187. *!       CALLED BY: STAFF.PRG
188. *!
189. *!*************************************************
190. PROCEDURE MENU
191. PARAMETER CHOICE
192. PRIVATE COL
193. CLEAR
194. @  0, 0 SAY " STAFF "
195. @  0,72 SAY DATE()
196. * ---CENTER THE MENU HEADING.
197. MENUHDG = "S T A F F    M A I N    M E N U"
198. COL = (80 - LEN(MENUHDG)) / 2
199. @  1,10 TO 12,69 DOUBLE
200. @  3,10 SAY "╟──────────────────────────────────────"
201. @  3,40 SAY "──────────────────────────────────────╢"
202. @  2,COL SAY MENUHDG
203. SET MESSAGE TO 18
204. MENUCHOICE = AT( CHOICE,"QAEPRC" )
205. IF (MENUCHOICE < 1) .OR. (MENUCHOICE > 6)
206.    MENUCHOICE = 3
207. ENDIF
208. COL = 33
209. @ 5,COL PROMPT " 0. QUIT "      MESSAGE "      RETURN
       TO DOS"
210. @ 6,COL PROMPT " 1. APPEND "    MESSAGE "      ADD
       NEW RECORDS"
211. @ 7,COL PROMPT " 2. EDIT/VIEW " MESSAGE "      VIEW,
       CHANGE, DELETE RECORDS"
212. @ 8,COL PROMPT " 3. REPORT "    MESSAGE "      PRINT
       REPORT(S)"
213. @ 9,COL PROMPT " 4. CHANGE SALARY VARIABLES" MESSAGE
       "     CHANGE SALARY VARIABLES FOR COMPUTING
       TOTAL SALARY"
214. * ---PRESS <ESC>, <RETURN>, <PGDN> OR THE FIRST
       CHARACTER "1"..."5".
215. * ---ASSIGNS 0 (ON <ESC>) OR 1 THRU 5 TO MENUCHOICE.
216. MENU TO MENUCHOICE
217. CHOICE = SUBSTR( "QQAERC",MENUCHOICE + 1,1 )
218. * ---RELEASE POW 18.
219. SET MESSAGE TO
220. RETURN
221. *!*************************************************
222. *!
223. *!    PROCEDURE: SAYREC
224. *!
```

APPENDIX VI. (staff.prg CONTINUED)

```
225. *!   CALLED BY: STA_EDIT     (PROCEDURE IN STAFF.PRG)
226. *!              : DOCONT     (PROCEDURE IN STAFF.PRG)
227. *!
228. *!         CALLS: STATLINE   (PROCEDURE IN STAFF.PRG)
229. *!              : STA_SAYS   (PROCEDURE IN STAFF.PRG)
230. *!
231. *!*************************************************
232. PROCEDURE SAYREC
233. *---"SAYREC" IS USED BY THE EDIT PROGRAM AND
        PROCEDURE DOCONT.
234. DO STATLINE WITH RECNO(),DELETED()
235. DO STA_SAYS
236. RETURN
237. *!*************************************************
238. *!
239. *!   PROCEDURE: GETKEY
240. *!
241. *!   CALLED BY: DOCONT      (PROCEDURE IN STAFF.PRG)
242. *!
243. *!*************************************************
244. PROCEDURE GETKEY
245. PARAMETER CHOICE,KEYCHARS
246. PRIVATE KEYCODE
247. CHOICE = "*"
248. DO WHILE .NOT. (CHOICE $ KEYCHARS)
249.    KEYCODE = INKEY()
250.    IF KEYCODE > 0
251.       CHOICE = UPPER(CHR(KEYCODE))
252.    ENDIF
253. ENDDO
254. RETURN
255. *!*************************************************
256. *!
257. *!      PROCEDURE: STATLINE
258. *!
259. *!      CALLED BY: STA_APPE  (PROCEDURE IN STAFF.PRG)
260. *!               : STA_EDIT  (PROCEDURE IN STAFF.PRG)
261. *!               : SAYREC    (PROCEDURE IN STAFF.PRG)
262. *!
263. *!*************************************************
264. PROCEDURE STATLINE
265. PARAMETER RECNUM,ISDELETED
266. @ 0, 8 SAY SUBSTR( STR( RECNUM + 1000000,7 ),2 )
267. @ 0,29 SAY "<       >"
268. @ 0,30 SAY " STAFF"
269. IF ISDELETED
270.    @ 0,50 SAY "*DELETED*"
271. ELSE
```

APPENDIX VI. (staff.prg CONTINUED)

```
272.    @ 0,50 SAY "          "
273. ENDIF
274. RETURN
275. *!*************************************************
276. *!
277. *!   PROCEDURE: SAYEOF
278. *!   CALLED BY: STA_EDIT  (PROCEDURE IN STAFF.PRG)
279. *!            : DOCONT    (PROCEDURE IN STAFF.PRG)
280. *!
281. *!*************************************************
282. PROCEDURE SAYEOF
283. PARAMETER ROW,OLDRECNUM
284. @ ROW,0 CLEAR
285. IF EOF()
286.    @ ROW,0 SAY "END-OF-FILE ENCOUNTERED"
287. ELSE
288.    @ ROW,0 SAY "BEGINNING-OF-FILE ENCOUNTERED"
289. ENDIF
290. WAIT
291. @ ROW,0 CLEAR
292. IF OLDRECNUM > 0
293.    GOTO OLDRECNUM
294. ENDIF
295. RETURN
296. *!*************************************************
297. *!
298. *!   PROCEDURE: SAYLINE
299. *!
300. *!   CALLED BY: STA_APPE    (PROCEDURE IN STAFF.PRG)
301. *!            : STA_EDIT    (PROCEDURE IN STAFF.PRG)
302. *!            : S_EDIT      (PROCEDURE IN STAFF.PRG)
303. *!            : DOCONT      (PROCEDURE IN STAFF.PRG)
304. *!
305. *!*************************************************
306. PROCEDURE SAYLINE
307. PARAMETER ROW,STRG
308. @ ROW,0 CLEAR
309. @ ROW,0 SAY STRG
310. RETURN
311. *!*************************************************
312. *!
313. *!   PROCEDURE: GOTOREC
314. *!
315. *!   CALLED BY: DOGOTO      (PROCEDURE IN STAFF.PRG)
316. *!
317. *!*************************************************
318. PROCEDURE GOTOREC
319. PARAMETER ROW,RECNUM,LASTRECNUM
```

APPENDIX VI. (staff.prg CONTINUED)

```
320. RECNUM = 0
321. @ ROW,0 CLEAR
322. @ ROW+1,17 SAY "{ 1 TO "
323. @ ROW+1,24 SAY SUBSTR( STR( LASTRECNUM+1000000,7),2)
        + " } + {RETURN}"
324. @ ROW,0 SAY "ENTER RECORD NUMBER" GET RECNUM;
325.    PICTURE "@Z 9999999" RANGE 0,LASTRECNUM
326. READ
327. @ ROW,0 CLEAR
328. IF RECNUM > 0
329.    GOTO RECNUM
330. ENDIF
331. RETURN
332. *!*************************************************
333. *!
334. *!    PROCEDURE: DOGOTO
335. *!
336. *!    CALLED BY: STA_EDIT     (PROCEDURE IN STAFF.PRG)
337. *!
338. *!           CALLS: GOTOREC   (PROCEDURE IN STAFF.PRG)
339. *!
340. *!*************************************************
341. PROCEDURE DOGOTO
342. PARAMETER ROW,RECNUM,LASTRECNUM
343. RECNUM = 0
344. @ ROW,0 CLEAR
345. MENUCHOICE = 4
346. @ ROW,0 SAY "GOTO:"
347. @ ROW, 7 PROMPT "TOP"
348. @ ROW,12 PROMPT "BOTTOM"
349. @ ROW,20 PROMPT "NUMBER"
350. @ ROW,28 PROMPT "RETURN"
351. MENU TO MENUCHOICE
352. CHOICE = SUBSTR( RETURNKEY+"TBR"+ RETURNKEY,
        MENUCHOICE + 1,1 )
353. @ ROW,0 CLEAR
354. DO CASE
355. CASE CHOICE = RETURNKEY
356.    RETURN
357. CASE CHOICE = "T"
358.    GOTO TOP
359.    RECNUM = RECNO()
360. CASE CHOICE = "B"
361.    GOTO BOTTOM
362.    RECNUM = RECNO()
363. CASE CHOICE = "R"
364.    DO GOTOREC WITH ROW,RECNUM,LASTRECNUM
365. ENDCASE
```

APPENDIX VI. (staff.prg CONTINUED)

```
366. RETURN
367. *!*****************************************************
368. *!
369. *!    PROCEDURE: DOCONT
370. *!
371. *!        CALLS: SAYREC       (PROCEDURE IN STAFF.PRG)
372. *!             : SAYLINE      (PROCEDURE IN STAFF.PRG)
373. *!             : GETKEY       (PROCEDURE IN STAFF.PRG)
374. *!             : SAYEOF       (PROCEDURE IN STAFF.PRG)
375. *!
376. *!*****************************************************
377. PROCEDURE DOCONT
378. PARAMETER ROW
379. PRIVATE OLDRECNUM
380. CHOICE = "Y"
381. DO WHILE CHOICE = "Y" .AND. .NOT. EOF()
382.    OLDRECNUM = RECNO()
383.    DO SAYREC
384.    DO SAYLINE WITH ROW+1,"CONTINUE? (Y/N)"
385.    DO GETKEY WITH CHOICE,"YN"+RETURNKEY
386.    @ ROW+1,0 CLEAR
387.    IF CHOICE = "Y"
388.       CONTINUE
389.    ENDIF
390. ENDDO
391. IF EOF()
392.    DO SAYEOF WITH ROW,OLDRECNUM
393. ENDIF
394. RETURN
395. *!*****************************************************
396. *!
397. *!    PROCEDURE: STA_FORM
398. *!
399. *!    CALLED BY: STA_APPE     (PROCEDURE IN STAFF.PRG)
400. *!             : STA_EDIT     (PROCEDURE IN STAFF.PRG)
401. *!
402. *!*****************************************************
403. PROCEDURE STA_FORM
404. CLEAR
405. @  0, 0 SAY SPACE(80)
406. @  0, 0 SAY "RECORD:"
407. @  0,72 SAY DATE()
408. @ PROMPTROW-1,0 SAY PROMPTBAR
409. *
410. @  6,11 SAY "LASTNAME  "
411. @ 4,4 TO 16,67 DOUBLE
412. @  6,28 SAY "FIRSTNAME "
413. @  6,40 SAY "INITIALS  "
```

APPENDIX VI. (staff.prg CONTINUED)

```
414. @  9,11 SAY "JOBCODE   "
415. @  9,21 SAY "TITLE     "
416. @ 12,11 SAY "BSALARY   "
417. @ 12,24 SAY "PBSALARY  "
418. @ 12,38 SAY "LONGEVITY "
419. @ 2,50 SAY "TOTAL SALARY - "
420. @ 2,7 SAY "FULL NAME  -"
421. RETURN
422. *!*************************************************
423. *!
424. *!   PROCEDURE: STA_SAYS
425. *!
426. *!   CALLED BY: STA_APPE    (PROCEDURE IN STAFF.PRG)
427. *!              : SAYREC    (PROCEDURE IN STAFF.PRG)
428. *!
429. *!*************************************************
430. PROCEDURE STA_SAYS
431. * ---USING STAFF.DBF
432. @  7,11 GET LASTNAME
433. @  7,28 GET FIRSTNAME
434. @  7,40 GET INITIALS
435. @ 10,11 GET JOBCODE
436. @ 10,21 GET TITLE
437. @ 13,11 GET BSALARY    PICTURE "999999"
438. @ 13,24 GET PBSALARY   PICTURE "999999"
439. @ 13,38 GET LONGEVITY  PICTURE "9999"
440. @ 2,20 SAY NAME
441. @ 2,65 SAY SALARY     PICTURE "$$$,$$$"
442. CLEAR GETS
443. RETURN
444. *!*************************************************
445. *!
446. *!   PROCEDURE: STA_GETS
447. *!
448. *!   CALLED BY: STA_APPE    (PROCEDURE IN STAFF.PRG)
449. *!              : STA_EDIT  (PROCEDURE IN STAFF.PRG)
450. *!
451. *!*************************************************
452. PROCEDURE STA_GETS
453. * ---USING STAFF.DBF
454. @  7,11 GET MLASTNAME
455. @  7,28 GET MFIRSTNAME
456. @  7,40 GET MINITIALS
457. @ 10,11 GET MJOBCODE
458. @ 10,21 GET MTITLE
459. @ 13,11 GET MBSALARY   PICTURE "999999"
460. @ 13,24 GET MPBSALARY  PICTURE "999999"
461. @ 13,38 GET MLONGEVITY PICTURE "9999"
```

APPENDIX VI. (staff.prg CONTINUED)

```
462. READ
463. RETURN
464. *!*************************************************
465. *!
466. *!       PROCEDURE: STA_STOR
467. *!
468. *!       CALLED BY: STA_APPE (PROCEDURE IN STAFF.PRG)
469. *!                : STA_EDIT (PROCEDURE IN STAFF.PRG)
470. *!
471. *!*************************************************
472. PROCEDURE STA_STOR
473. * ---USING STAFF.DBF
474. * ---INITIALIZE MEMVARS WITH FIELD CONTENTS.
475. STORE LASTNAME   TO MLASTNAME
476. STORE FIRSTNAME  TO MFIRSTNAME
477. STORE INITIALS   TO MINITIALS
478. STORE JOBCODE    TO MJOBCODE
479. STORE TITLE      TO MTITLE
480. STORE BSALARY    TO MBSALARY
481. STORE PBSALARY   TO MPBSALARY
482. STORE LONGEVITY  TO MLONGEVITY
483. RETURN
484. *!*************************************************
485. *!
486. *!    PROCEDURE: STA_REPL
487. *!
488. *!    CALLED BY: STA_APPE     (PROCEDURE IN STAFF.PRG)
489. *!             : STA_EDIT     (PROCEDURE IN STAFF.PRG)
490. *!
491. *!        CALLS: TOTSALARY    (PROCEDURE IN STAFF.PRG)
492. *!
493. *!*************************************************
494. PROCEDURE STA_REPL
495. * ---USING STAFF.DBF
496. IF .NOT. EOF()
497.    * ---REPLACE ONLY IF THERE IS AN AVAILABLE RECORD.
498.
499.    REPLACE;
500.       LASTNAME   WITH PROPER(MLASTNAME),;
501.       FIRSTNAME  WITH PROPER(MFIRSTNAME),;
502.       INITIALS   WITH MINITIALS,;
503.       JOBCODE    WITH MJOBCODE,;
504.       TITLE      WITH MTITLE,;
505.       BSALARY    WITH MBSALARY,;
506.       PBSALARY   WITH MPBSALARY
507.    REPLACE;
508.       LONGEVITY  WITH MLONGEVITY
509.    REPLACE NAME WITH RTRIM(MFIRSTNAME)+ " "
```

APPENDIX VI. (staff.prg CONTINUED)

```
          +RTRIM(MLASTNAME)
510.    DO TOTSALARY
511. ENDIF
512. RETURN
513. *!*****************************************************
514. *!
515. *!   PROCEDURE: SALVARIABLES
516. *!
517. *!   CALLED BY: STA_REPO    (PROCEDURE IN STAFF.PRG)
518. *!            : TOTSALARY   (PROCEDURE IN STAFF.PRG)
519. *!
520. *!        USES: SALVARI.DBF
521. *!
522. *!*****************************************************
523. PROCEDURE SALVARIABLES
524. PUBLIC MSWCF, MUECI, MOASI1P, MOASI1, MOASI2P,
           MOASI2, MOASI3, MINSUR
525. SELECT 2
526. USE SALVARI
527. MSWCF=SWCF/100
528. MUECI=UECI/100
529. MOASI1=OASI1/100
530. MOASI1P=OASI1P
531. MOASI2=OASI2/100
532. MOASI2P=OASI2P
533. MOASI3=OASI3/100
534. MINSUR=INSUR
535. USE
536. SELECT 1
537. RETURN
538. *!*****************************************************
539. *!
540. *!   PROCEDURE: TOTSALARY
541. *!
542. *!   CALLED BY: S_EDIT      (PROCEDURE IN STAFF.PRG)
543. *!            : STA_REPL    (PROCEDURE IN STAFF.PRG)
544. *!
545. *!       CALLS: SALVARIABLES(PROCEDURE IN STAFF.PRG)
546. *!
547. *!*****************************************************
548. PROCEDURE TOTSALARY
549. DO SALVARIABLES
550. OASICON=BSALARY*MOASI3
551. IF OASICON>965
552.    OASICON=965
553. ENDIF
554. IF PBSALARY*(8/12)<MOASI1P
555.    SALA=PBSALARY*(8/12)+BSALARY*(4/12)
```

APPENDIX VI. (staff.prg CONTINUED)

```
556.     IF SALA>MOASI1P
557.        TOASI1=(MOASI1P-(PBSALARY*8/12))*MOASI1
558.     ELSE
559.        TOASI1=BSALARY*(4/12)*MOASI1
560.     ENDIF
561. ELSE
562.     TOASI1=0
563. ENDIF
564. SALA1=BSALARY*8/12
565. IF SALA1>MOASI2P
566.     TOASI2=MOASI2P*MOASI2
567. ELSE
568.     TOASI2=SALA1*MOASI2
569. ENDIF
570. TOTSAL= LONGEVITY+BSALARY +(BSALARY*(MSWCF+MUECI))
        +TOASI1+TOASI2+OASICON+IIF(BSALARY>7000,MINSUR,0)
571. REPLACE SALARY WITH TOTSAL
572. RETURN
573. *!*************************************************
574. *!
575. *!    PROCEDURE: S_EDIT
576. *!
577. *!    CALLED BY: STAFF.PRG
578. *!
579. *!         CALLS: FORM         (PROCEDURE IN STAFF.PRG)
580. *!              : S_SAYS       (PROCEDURE IN STAFF.PRG)
581. *!              : TOTSALARY    (PROCEDURE IN STAFF.PRG)
582. *!              : S_STOR       (PROCEDURE IN STAFF.PRG)
583. *!              : SAYLINE      (PROCEDURE IN STAFF.PRG)
584. *!              : S_GETS       (PROCEDURE IN STAFF.PRG)
585. *!              : S_REPL       (PROCEDURE IN STAFF.PRG)
586. *!
587. *!            USES: SALVARI.DBF
588. *!
589. *!*************************************************
590. PROCEDURE S_EDIT
591. PUBLIC MSWCF, MUECI, MOASI1P, MOASI1, MOASI2P,
        MOASI2, MOASI3, MINSUR
592. SELECT 2
593. USE SALVARI
594. CLEAR
595. DO FORM
596. DO S_SAYS
597. ROW=22
598. DO WHILE .T.
599.     @ ROW,0 SAY "EDIT/VIEW:  EDIT  <RETURN>"
600.     @ ROW,12 PROMPT "EDIT"
601.     @ ROW,19 PROMPT "RETURN"
```

APPENDIX VI. (staff.prg CONTINUED)

```
602.     MENU TO MENUCHOICE
603.     EDITCHOICE = SUBSTR(RETURNKEY+"E"+
             RETURNKEY,MENUCHOICE+1,1)
604.     DO CASE
605.     CASE EDITCHOICE = RETURNKEY
606.        SELECT 1
607.        GOTO TOP
608.        @23,20 SAY 'PLEASE WAIT-UPDATING TOTAL
               SALARIES'
609.        DO WHILE .NOT. EOF()
610.           DO TOTSALARY
611.           SKIP
612.        ENDDO
613.        GOTO TOP
614.        EXIT
615.     CASE EDITCHOICE = "E"
616.        * ---EDIT THE RECORD.
617.        DO S_STOR
618.        DO SAYLINE WITH ROW,"PRESS {CTRL-W} TO EXIT"
619.        DO S_GETS
620.        DO S_REPL
621.     ENDCASE
622. ENDDO
623. RETURN
624. *!*************************************************
625. *!
626. *!    PROCEDURE: FORM
627. *!
628. *!    CALLED BY: S_EDIT       (PROCEDURE IN STAFF.PRG)
629. *!
630. *!*************************************************
631. PROCEDURE FORM
632. @  0, 0 SAY SPACE(80)
633. @  0, 0 SAY "RECORD: 1"
634. @  0,72 SAY DATE()
635. @ 5,27 SAY "TOTAL SALARY VARIABLES"
636. @ PROMPTROW-1,0 SAY PROMPTBAR
637. @  9,19 SAY "SWCF      "
638. @ 7,12 TO 17,62 DOUBLE
639. @  9,29 SAY "UECI      "
640. @ 13,19 SAY "OASI1     "
641. @ 13,29 SAY "OASI1P    "
642. @ 13,39 SAY "OASI2     "
643. @ 13,50 SAY "OASI2P    "
644. @  9,49 SAY "OASI3     "
645. @  9,39 SAY "INSUR     "
646. @ 10,24 SAY "%"
647. @ 10,34 SAY "%"
```

APPENDIX VI. (staff.prg CONTINUED)

```
@ 10,54 SAY "%"
@ 14,24 SAY "%"
@ 14,44 SAY "%"
RETURN
*!*************************************************
*!
*!   PROCEDURE: S_REPL
*!
*!   CALLED BY: S_EDIT      (PROCEDURE IN STAFF.PRG)
*!
*!*************************************************
PROCEDURE S_REPL
* ---USING SALVARI.DBF
IF .NOT. EOF()
   * ---REPLACE ONLY IF THERE IS AN AVAILABLE RECORD.
   REPLACE;
      SWCF       WITH MSWCF,;
      UECI       WITH MUECI,;
      OASI1      WITH MOASI1,;
      OASI1P     WITH MOASI1P,;
      OASI2      WITH MOASI2,;
      OASI2P     WITH MOASI2P,;
      OASI3      WITH MOASI3
   REPLACE;
      INSUR      WITH MINSUR
ENDIF
RETURN
*!*************************************************
*!
*!   PROCEDURE: S_SAYS
*!
*!   CALLED BY: S_EDIT      (PROCEDURE IN STAFF.PRG)
*!
*!*************************************************
PROCEDURE S_SAYS
* ---USING SALVARI.DBF
@ 10,19 GET SWCF       PICTURE "99.99"
@ 10,29 GET UECI       PICTURE "99.99"
@ 10,49 GET OASI3      PICTURE "99.99"
@ 10,39 GET INSUR      PICTURE "999999"
@ 14,19 GET OASI1      PICTURE "99.99"
@ 14,29 GET OASI1P     PICTURE "999999"
@ 14,39 GET OASI2      PICTURE "99.99"
@ 14,50 GET OASI2P     PICTURE "999999"
CLEAR GETS
RETURN
*!*************************************************
*!
```

APPENDIX VI. (staff.prg CONTINUED)

```
696. *!   PROCEDURE: S_STOR
697. *!
698. *!   CALLED BY: S_EDIT      (PROCEDURE IN STAFF.PRG)
699. *!
700. *!*************************************************
701. PROCEDURE S_STOR
702. STORE SWCF        TO MSWCF
703. STORE UECI        TO MUECI
704. STORE OASI1       TO MOASI1
705. STORE OASI1P      TO MOASI1P
706. STORE OASI2       TO MOASI2
707. STORE OASI2P      TO MOASI2P
708. STORE OASI3       TO MOASI3
709. STORE INSUR       TO MINSUR
710. RETURN
711. *!*************************************************
712. *!
713. *!   PROCEDURE: S_GETS
714. *!
715. *!   CALLED BY: S_EDIT      (PROCEDURE IN STAFF.PRG)
716. *!
717. *!*************************************************
718. PROCEDURE S_GETS
719. * ---USING SALVARI.DBF
720. @ 10,19 GET MSWCF       PICTURE "99.99"
721. @ 10,29 GET MUECI       PICTURE "99.99"
722. @ 10,39 GET MINSUR      PICTURE "999999"
723. @ 10,49 GET MOASI3      PICTURE "99.99"
724. @ 14,19 GET MOASI1      PICTURE "99.99"
725. @ 14,29 GET MOASI1P     PICTURE "999999"
726. @ 14,39 GET MOASI2      PICTURE "99.99"
727. @ 14,50 GET MOASI2P     PICTURE "999999"
728. READ
729. RETURN
730. *!*************************************************
731. *!
732. *!   PROCEDURE: STA_APPE
733. *!
734. *!   CALLED BY: STAFF.PRG
735. *!
736. *!       CALLS: STA_FORM     (PROCEDURE IN STAFF.PRG)
737. *!            : STA_SAYS     (PROCEDURE IN STAFF.PRG)
738. *!            : STA_STOR     (PROCEDURE IN STAFF.PRG)
739. *!            : STATLINE     (PROCEDURE IN STAFF.PRG)
740. *!            : SAYLINE      (PROCEDURE IN STAFF.PRG)
741. *!            : STA_GETS     (PROCEDURE IN STAFF.PRG)
742. *!            : STA_REPL     (PROCEDURE IN STAFF.PRG)
743. *!
```

APPENDIX VI. (staff.prg CONTINUED)

```
744. *!*************************************************
745. PROCEDURE STA_APPE
746. PRIVATE ROW,RECNUM,RECNUMOFS
747. PRIVATE ISBLANK,ISUNIQUE,ISCARRY,ISDELETED
748. * ---INITIALIZE LOCAL MEMORY VARIABLES.
749. ROW = PROMPTROW
750. RECNUMOFS = RECCOUNT()
751. STORE .F. TO ISBLANK,ISUNIQUE,ISCARRY,ISDELETED
752. EXPR = ""
753. * ---START BY ADDING ONE RECORD.
754. CHOICE = RETURNKEY
755. * ---THE FOLLOWING LOOP IS REALLY A "REPEAT/UNTIL
        <COND>".
756. DO WHILE .T.
757.    * ---START DATABASE FILE ON CORRECT PAGE.
758.    DO STA_FORM
759.    IF (CHOICE = RETURNKEY) .OR. ISCARRY
760.       * ---ADD ANOTHER RECORD.
761.       RECNUMOFS = RECNUMOFS + 1
762.       IF .NOT. ISCARRY
763.          * ---INITIALIZE MEMORY VARIABLES WITH
                 BLANKS.
764.          GOTO BOTTOM
765.          IF .NOT. EOF()
766.             SKIP
767.          ENDIF
768.          DO STA_SAYS
769.          @2,0 CLEAR TO 2,78
770.          DO STA_STOR
771.          GOTO BOTTOM
772.       ENDIF
773.       ISCARRY = .F.
774.    ENDIF
775.    DO STATLINE WITH RECNUMOFS,ISDELETED
776.    @ 0,50 SAY "*BLANK*  "
777.    * ---ENTER KEY FIELD VALUES.
778.    DO SAYLINE WITH ROW,"PRESS {CTRL-W} TO EXIT"
779.    EXPR=" "
780.    ISBLANK= .F.
781.    ISUNIQUE= .F.
782.    IF ISBLANK
783.       ISDELETED = .T.
784.    ELSE
785.       DO WHILE .T.
786.          DO STATLINE WITH RECNUMOFS,ISDELETED
787.          @ 0,50 SAY "*BLANK*  "
788.          DO SAYLINE WITH ROW,"PRESS {CTRL-W} TO EXIT"
789.          DO STA_GETS
```

APPENDIX VI. (staff.prg CONTINUED)

```
790.            EXIT
791.         ENDDO
792.      ENDIF
793.      DO STATLINE WITH RECNUMOFS,ISDELETED
794.      * ---LOOP UNTIL ADD, CARRY, EDIT, OR FINISHED IS
             SELECTED.
795.      * ---THE FOLLOWING LOOP IS REALLY A "REPEAT/UNTIL
             <COND>".
796.      MENUCHOICE = 4
797.      DO WHILE .T.
798.         @ ROW,0 CLEAR
799.         @ ROW, 0 SAY "APPEND:"
800.         @ ROW,10 PROMPT "ADD-ANOTHER"
801.         @ ROW,24 PROMPT "CARRY-ADD"
802.         @ ROW,36 PROMPT "EDIT"
803.         @ ROW,43 PROMPT "FINISHED"
804.         @ ROW,54 SAY "<DEL>"
805.         @ ROW,55 PROMPT "DEL"
806.         MENU TO MENUCHOICE
807.         CHOICE =SUBSTR( "F"+RETURNKEY+"CEF"+ DELRECORD,
                MENUCHOICE + 1,1 )
808.         DO CASE
809.         CASE CHOICE = DELRECORD
810.            * ---TOGGLE ISDELETED FLAG.
811.            ISDELETED = .NOT. ISDELETED
812.            DO STATLINE WITH RECNUMOFS,ISDELETED
813.         CASE CHOICE = "E"
814.            * ---RE-EDIT THE RECORD.
815.            ISDELETED = .F.
816.         CASE CHOICE $ "CF"+RETURNKEY
817.            * ---FINISHED, ADD-ANOTHER, OR CARRY-ADD.
818.            ISCARRY = (CHOICE = "C")
819.            IF ISDELETED
820.               * ---RESET OFFSET SO AS NOT TO INCREMENT.
821.               RECNUMOFS = RECNUMOFS - 1
822.            ELSE
823.               * ---SAVE THE MEMVAR VALUES.
824.               APPEND BLANK
825.               DO STA_REPL
826.            ENDIF
827.         ENDCASE
828.         * ---CONDITION TO EXIT INNER LOOP.
829.         IF CHOICE $ "CEF"+RETURNKEY
830.            EXIT
831.         ENDIF
832.      ENDDO
833.      * ---CONDITION TO EXIT OUTER LOOP.
834.      IF CHOICE = "F"
```

APPENDIX VI. (staff.prg CONTINUED)

```
835.        IF .NOT. EMPTY(LASTNAME)
836.           EXIT
837.        ELSE
838.           DELETE
839.           EXIT
840.        ENDIF
841.
842.     ENDIF
843. ENDDO
844. GOTO TOP
845. RETURN
846. *!*************************************************
847. *!
848. *!    PROCEDURE: STA_EDIT
849. *!
850. *!    CALLED BY: STAFF.PRG
851. *!
852. *!         CALLS: STA_FORM     (PROCEDURE IN STAFF.PRG)
853. *!              : SAYREC       (PROCEDURE IN STAFF.PRG)
854. *!              : SAYEOF       (PROCEDURE IN STAFF.PRG)
855. *!              : STA_STOR     (PROCEDURE IN STAFF.PRG)
856. *!              : SAYLINE      (PROCEDURE IN STAFF.PRG)
857. *!              : STA_GETS     (PROCEDURE IN STAFF.PRG)
858. *!              : STA_REPL     (PROCEDURE IN STAFF.PRG)
859. *!              : DOGOTO       (PROCEDURE IN STAFF.PRG)
860. *!              : STATLINE     (PROCEDURE IN STAFF.PRG)
861. *!
862. *!*************************************************
863. PROCEDURE STA_EDIT
864. PARAMETER ISEDITED
865. PRIVATE ROW,LASTPAGE,EDITCHOICE
866. PRIVATE ISBLANK,ISUNIQUE
867. ROW = PROMPTROW
868. EXPR = ""
869. STORE .F. TO ISEDITED,ISBLANK,ISUNIQUE
870. DO STA_FORM
871. DO SAYREC
872. MENUCHOICE = 10
873. EDITCHOICE = "*"
874. * ---LOOP UNTIL {RETURN} IS PRESSED.
875. * ---THE FOLLOWING LOOP IS REALLY A "REPEAT/UNTIL
        <COND>".
876. DO WHILE .T.
877.    IF .NOT. (EDITCHOICE $ "NP"+DELRECORD)
878.       @ ROW,0 CLEAR
879.    ENDIF
880.    @ ROW,0 SAY "EDIT/VIEW:  EDIT   GOTO  <DELETE> "
881.    @ ROW,12 PROMPT "EDIT"
```

APPENDIX VI. (staff.prg CONTINUED)

```
882.     @ ROW,19 PROMPT "GOTO"
883.     @ ROW,26 PROMPT "DELETE"
884.     @ ROW+1,12 SAY "NEXT-RECORD   PREV-RECORD
           <RETURN>"
885.     @ ROW+1,12 PROMPT "NEXT-RECORD"
886.     @ ROW+1,26 PROMPT "PREV-RECORD"
887.     @ ROW+1,41 PROMPT "RETURN"
888.
889.     MENU TO MENUCHOICE
890. EDITCHOICE = SUBSTR(RETURNKEY+"EG"+DELRECORD+ "NP"
        +RETURNKEY,MENUCHOICE+1,1)
891.     DO CASE
892.     CASE EDITCHOICE = RETURNKEY
893.        EXIT
894.     CASE EDITCHOICE = "N"
895.        * ---NEXT RECORD.
896.        OLDRECNUM = RECNO()
897.        SKIP
898.        IF EOF()
899.           DO SAYEOF WITH ROW,OLDRECNUM
900.        ELSE
901.           DO SAYREC
902.        ENDIF
903.     CASE EDITCHOICE = "P"
904.        * ---PREVIOUS RECORD.
905.        OLDRECNUM = RECNO()
906.        SKIP -1
907.        IF BOF()
908.           DO SAYEOF WITH ROW,OLDRECNUM
909.        ELSE
910.           DO SAYREC
911.        ENDIF
912.     CASE EDITCHOICE = "E"
913.        * ---EDIT THE RECORD.
914.        ISEDITED = .T.
915.        DO STA_STOR
916.        DO WHILE .T.
917.           DO SAYLINE WITH ROW,"PRESS {CTRL-W} TO EXIT"
918.           DO STA_GETS
919.           DO STA_FORM
920.           DO SAYREC
921.           EXIT
922.        ENDDO
923.        DO STA_REPL
924.        DO SAYREC
925.     CASE EDITCHOICE = "G"
926.        * ---GOTO A RECORD.
927.        DO DOGOTO WITH ROW,RECNUM,LASTREC
```

APPENDIX VI. (staff.prg CONTINUED)

```
928.        IF RECNUM > 0
929.           DO SAYREC
930.        ENDIF
931.        MENUCHOICE = 3
932.     CASE EDITCHOICE = DELRECORD
933.        * ---DELETE THE RECORD.
934.        ISEDITED = .T.
935.        IF DELETED()
936.           RECALL
937.        ELSE
938.           DELETE
939.        ENDIF
940.        DO STATLINE WITH RECNO(),DELETED()
941.     ENDCASE
942. ENDDO
943. RETURN
944. *!*************************************************
945. *!
946. *!    PROCEDURE: STA_REPO
947. *!
948. *!    CALLED BY: STAFF.PRG
949. *!
950. *!        CALLS: SALVARIABLES(PROCEDURE IN STAFF.PRG)
951. *!
952. *!    REPORT FORMS: &FILENAME
953. *!
954. *!*************************************************
955. PROCEDURE STA_REPO
956. PRIVATE FILENAME,SAVRECNUM
957. SAVRECNUM = RECNO()
958. DO SALVARIABLES
959. CLEAR
960. @  0, 0 SAY "P R I N T    R E P O R T"
961. @  0,72 SAY DATE()
962. @  1, 0 SAY PROMPTBAR
963. * ---DISPLAY REPORT FORMS.
964. @  5, 0 SAY REPLICATE( CHR(22),80 )
965. @  6, 0 SAY "DIRECTORY OF STA_*.FRX"
966. DIR STA_*.FRX
967. FILENAME = "     "
968. @3,0 SAY "ENTER REPORT FORM FILENAME: STA_     .FRX"
969. @  3,32 GET FILENAME PICTURE "@!"
970. READ
971. * ---REMOVE THE FILE EXTENSION.
972. FILENAME = UPPER( FILENAME + "." )
973. FILENAME = TRIM( SUBSTR( FILENAME,1,
         AT(".",FILENAME)-1 ) )
974. IF "" = FILENAME
```

APPENDIX VI. (staff.prg CONTINUED)

```
975.    RETURN
976. ENDIF
977. FILENAME = "STA_" + FILENAME + ".FRX"
978. * ---IF THE FILE DOES NOT EXIST, CREATE IT OR EXIT.
979. IF .NOT. FILE( FILENAME )
980.    CHOICE = " "
981.    @ 3,0 CLEAR
982.    @ 3,0 SAY FILENAME + " DOES NOT EXIST.  CREATE
              IT? (Y/N)";
983.       GET CHOICE PICTURE "!"
984.    READ
985.    IF CHOICE <> "Y"
986.       RETURN
987.    ENDIF
988.    CREATE REPORT &FILENAME
989.    RETURN
990. ENDIF
991. * ---GET THE FOR <EXP>.
992. EXPR = ""
993. CHOICE = " "
994. @ 2,0 CLEAR
995. * ---PRINT THE REPORT.
996. @ 3,0 SAY "PRINTING REPORT..."
997. SET ESCAPE ON
998. SET CONSOLE OFF
999. IF "" <> TRIM( EXPR )
1000.    REPORT FORM &FILENAME FOR &EXPR HEADING EXPR
             NOEJECT TO PRINT
1001. ELSE
1002.    REPORT FORM &FILENAME NOEJECT TO PRINT
1003. ENDIF
1004. SET CONSOLE ON
1005. SET ESCAPE OFF
1006. IF SAVRECNUM > 0
1007.    GOTO SAVRECNUM
1008. ENDIF
1009. RETURN
1010. *!*************************************************
1011. *!
1012. *!   PROCEDURE: ERROR
1013. *!
1014. *!   CALLED BY: STAFF.PRG
1015. *!
1016. *!        CALLS: CLOSING   (PROCEDURE IN STAFF.PRG)
1017. *!
1018. *!*************************************************
1019. PROCEDURE ERROR
1020. PARAMETERS MESS
```

APPENDIX VI. (staff.prg CONTINUED)

```
1021. SET CONSOLE ON
1022. CLEAR
1023. @12,10 SAY MESSAGE()
1024. @13,10 SAY "PLEASE TRY AGAIN LATER"
1025. @15,10 SAY " "
1026. WAIT "          PRESS ANY KEY TO CONTINUE"
1027. ON ERROR
1028. DO CLOSING
1029. RETURN
1030. *!*************************************************
1031. *!
1032. *!    PROCEDURE: ERROR1
1033. *!
1034. *!    CALLED BY: SAVING     (PROCEDURE IN STAFF.PRG)
1035. *!
1036. *!*************************************************
1037. PROCEDURE ERROR1
1038. PARAMETERS MESS
1039. SET CONSOLE ON
1040. CLEAR
1041. @12,10 SAY MESSAGE()
1042. @13,10 SAY "PLEASE WAIT - SOMEONE IS USING
          STAFF.DBF"
1043. @15,10 SAY "PRESS THE <ESC> KEY TO QUIT WITHOUT
          UPDATING STAFF.DBF "
1044. @17,10 SAY " "
1045.
1046. WAIT "          PRESS ANY KEY TO TRY AGAIN"
1047. SET CONSOLE OFF
1048. IF LASTKEY()=27
1049.    RETURN
1050. ELSE
1051.    RETRY
1052. ENDIF
1053. *: EOF: STAFF.PRG
```

APPENDIX VII. Monthly Progress Reports

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

2 Oct 1989

Re: Doctor of Engineering Internship Progress Report
(28 Aug 89 - 30 Sept 89)

This letter summarizes progress for the period 28 August to 30 September 1989.

Satisfactory progress is being made toward accomplishing the organizational objectives in the Facilities, Planning and Construction office. I spent the first week talking to various organizational managers in order to understand the who, what, when, why and how construction projects are accomplished in the Texas A&M system. The method of doing construction is not to different than the way the Air Force does it which facilitated my understanding of the organization.

During the next three weeks, my time was divided into three major areas. First, I spent several days reviewing the plans and specifications for the two major projects where I'll be the project manager. Both projects, the Southside Parking Garage and the Wave Tank will provide an excellent means to obtain the objectives listed under the Construction Division of the proposal. I've already noticed that in one aspect or another, every class I had at Texas A&M will be a factor in accomplishing the objectives of the internship. Currently, I visit both job sites daily and have seen methods of construction that I haven't seen before which is extremely interesting. For example, the 15' x 30' x 40' deep pit at the Wave Tank is being constructed in 5' segments from the top down. It will be interesting to follow the work as it progresses this month. I've also been involved in working several construction problems that have occurred with the Wave Tank like differing site conditions during the lime injection phase. To date, the Wave Tank contractor has not provided a working schedule on Primavera but the Southside Parking Garage has submitted a 73 activity network that I've been analyzing using his target schedule and two month schedule update. The CVEN 642 class has

APPENDIX VII. (CONTINUED)

been extremely helpful in analyzing the schedule. There have been additional minor contractual issues that I will not mention in this progress report that I've worked. Both projects are progressing satisfactory and I'm looking forward getting more involved has time continues.

Besides the two construction projects, I began working with James Davidson, an architect in the planning division, on a future project at Galveston. The project is a little landscape work ($500,000) that the Galveston campus would like planned and installed. My involvement in this project is to see how a project goes from the conception stage all the way through completion. Since this is a small job, I should be able to follow most of it during my internship. To date, all we have done was to meet with the user and identify their request. The project has already been given the initial okay by the Board of Regents to proceed with the project conception. My involvement with this project should satisfy my accomplishing the objectives as listed in the Planning Division section of the proposal.

The final major work area this last month has been spent in learning the computer software and hardware available in the office. This organization has definitely taken the initiative in updating their work environment to encompass the latest computer tools available to help manage complex construction and management issues. The Novell network and the programs they have written have enable the organization to accomplish tasks that took several days or were simply not done because of time. I expect to spend a little time each month looking at the various programs and recommending how a good system could be even expanded.

During the next month, I plan on looking at cost projections. Due to the method of funding in the Texas A&M system, the organization forecast their anticipated payments for the upcoming month. With the large data base on previous construction payments, they (several members of the organization) have developed a mathematical model in order to help predict the future projected costs of construction. I plan to look at this model and see if a different model may provide a better projection. I will also continue with the two projects and the computer applications in the organization.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

3 Nov 1989

Re: Doctor of Engineering Internship Progress Report
(1 Oct 89 - 31 Oct 89)

This letter summarizes progress for the period 1 October to 31 October 1989.

I continued to meet with various organizational managers in order to understand the construction process in the Texas A&M system.

During the first week of October, we had monthly construction update meetings for the both projects, the Parking Garage and the Wave Tank. The meetings were productive and several additional design questions and consideration were addressed and solved later in the week. For example, the door hardware for the Wave Tank facility originally called for lever door handles which the University is trying to eliminate because of maintenance problems. I meet with physical plant key personnel to establish a new hardware specification that is consistent with other buildings on campus. We were trying to avoid specifying uncommon door hardware which would cause future maintenance problems or additional stocking.

There are several claims that have been initiated this last month that I'm at present working with the Inspector, anotner Project Manager or the architect in order to resolve.

During the second week of October, the inspector on the Wave Tank project was on vacation so I spent most of my time on the job site and recording the daily activity in the project log book. Besides the daily inspection, I was able to take several faculty members and students on a tour of the two projects. The 15' x 30' x 35' deep pit at the Wave Tank, which is constructed in 5' segments from the top down, has made very good progress once the contractor changed his method of excavation. The pit

APPENDIX VII. (CONTINUED)

excavation was a prime example of using the wrong type of equipment for the job. The contractor originally planned to use a clam shell for the excavation but the clay soil made it very time-consuming and nearly nonproductive so the contractor switched to a bigger bucket on the miniature shovel he rented which allowed him to increase productivity. The project is approximately two weeks behind schedule because of lime injection problems and now compaction problems. The exact delay impacts are unknown at this time since the contractor is still working out logic problems in his submitted construction schedule.

The third and fourth week I spent a lot more time in the office working on the Primavera schedules and the database program used by our office personnel. I was able to generate clear "D" size time-line schedule plots of the projects. I also spent several afternoons reconfiguring the standard reports in order to generate specific detailed reports to compare monthly and target activity dates. During the next month, I'll be able to run the reports and see what benefits they will be in analyzing contractor progress.

The databases used by the organization contain contract information as far back has 1984. I spent two days looking at just a few of the files used by the organization. Of primary interest was the database containing contract payments. I was able to determine that we have over 800 recorded contractor payments. It is my intent to analyze this data with Earl Fratus and see if we can develop a model so we can predict future payment schedules. Currently, the organization uses three quadratic equations in order to predict future payments based on the original contract price. We, Earl and I, plan on looking at a cubic equation or even a higher-order equation which would include such variables as contract price, project duration, type of construction and even location. Our tentative plan is to start the research and work during January 1990.

One day this month I was able to take part in an architect selection process. It was a worthwhile experience to gain insight in the selection process at Texas A&M. There are areas in the process which could be improved and the planning division has recognized them and is working toward improving the selection process. During the next month, I will continue working on the two projects and computer applications in the organization.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

1 Dec 1989

Re: Doctor of Engineering Internship Progress Report
(1 Nov 89 - 30 Nov 89)

This letter summarizes progress for the period 1 November to 30 November 1989. It highlights progress made in obtaining the objectives as outlined in my proposal. This is the third progress report written since the start of the internship on 28 Aug 89.

I'm beginning to feel like I understand the construction process. There are a few areas, in administration that I do not understand; however, that should be cleared up in the next month. Whenever I get the chance, I meet with various organizational managers in order to discuss the construction process in the Texas A&M system.

The majority of the month was spent in the office working on various computer applications. Most of my time was spent on Primavera and preparing various reports and plots. Primavera is an excellent package that has a lot of power; however, it is not being used to its full extent. In both projects I'm working on, the parking garage and the wave tank, neither contractor is tracking resources or costs. They're using the program for scheduling only. Even then, Primavera is an excellent package and can aid in identifying problem areas and serve as a management tool for scheduling and doing what if analysis.

This last month, there were three areas where I used Primavera. I continued to use it on the parking garage in order to plot the time line and bar charts. The contractor gives us a disk at the beginning of each month and I generate the plots based on his data. Earlier in the project, the contractor was sending the data to their headquarters in Denver in order to be plotted; however, that process took close to two weeks and by the time we received the plots the data was outdated. Besides late

APPENDIX VII. (CONTINUED)

plots, our office was not able to get the information on disk and we would have had to enter the data by hand ourselves. Now, we get the data disks two days before the monthly meeting and I'm able to generate up-to-date time line plots and various reports in order to track the project. This practice has worked well for the last two months.

The wave tank project presented a different and more challenging problem concerning scheduling. The contractor was three months late in delivering a schedule to this office and even then the schedule had some logic problems. The contractor knew the schedule had some minor problems but no longer had a source to do the updates on Primavera. He had originally contracted out this work, but his source was too busy and could not continue. This was when I was faced with a major ethical issue that I had to surmise. I was asked by the contractor to do his scheduling on the side. I discussed the problem with various managers in the office and at first, we thought there was a slim chance it could be done if all I did was the manual work but made no scheduling decisions. All I would do is the manual work of doing the scheduling changes as directed by the contractor; however, we very soon realized that the ethical issues were enormous and it could put all parties in an adverse position. There simply was no way I could work both sides of the fence and remain neutral especially in the case of a claim. Nor could I legally do the work at home when I did not have the software or plotter. The bottom line, was that it simply could not be done ethically even if I had the software and plotter. However, since this project contains another contractor who will install the wave machine, the schedule becomes even more critical, so we would like to continue doing the scheduling with the contractor supplying the data dates. We have already worked with the contractor to fix his logic problems and will negotiate a revision to the contract to have this office do the actual updates to his schedule with the contractor supplied data.

I also used Primavera to illustrate a potential construction problem in the upcoming MSC project. It appears that the contract (during the 100% design review) was going to limit the work on the catering kitchen to a set time frame and length.
Not only were we able to show that the work could not be done in the allocated four months but we illustrated an acceptable schedule for all parties involved. This should

APPENDIX VII. (CONTINUED)

have prevented some serious problems during the actual construction next year.

I have managed to limit my time spent on the actual job sites. I could easily spend most of the day at both sites since there are several aspects of construction that I haven't seen before, like the post tensioning of the slabs and beams in the parking garage. I still try to get to each site during major activities like large concrete pours. I've also began to take pictures in order to show the construction progress.

There were several small computer hardware and software issues that I worked during November. We purchased an organizational chart program so I spent a day doing charts for the construction and planning division. I also assisted in repairing several hardware problems that occurred during the month. I've noticed several areas of computer maintenance and additional software requirements that were lacking in the organization. The construction division has permitted me to purchase several computer programs that may eliminate a majority of potential problems if proper action is taken. A few of the software packages will also increase productivity. The computer problem is not limited to this organization. Everywhere I go, there are potential computer problems that could be eliminated or at least become less severe if a few hundred dollars of software and accessories were purchased. I'm considering writing a two page article on this issue and see if I could get it published in several computer and engineering magazines.

During the next month, I will begin data collection on establishing a cost estimate model for predicting monthly project costs. I also plan on finalizing the objectives for my internship.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

2 Jan 1990

Re: Doctor of Engineering Internship Progress Report
(1 Dec 89 - 31 Dec 90)

This letter summarizes progress for the period 1 December to 31 December 1989. This is the fourth progress report written since the start of the internship on 28 Aug 89.

The month of December seemed to fly by with all the construction activity and computer problems. There were several very large concrete pours on both the wave tank and parking garage. I've been spending extra time monitoring the construction work since I've never been that close to post tensioned concrete before now. I've read about it and even taught about its use and purpose; however, I've never been on a job site which actually used it. One definite thing I've learned is that when dealing with post tensioned concrete, care must be taken when laying out the cable and remembering where the cables are located. For example, the contractor has broken two cables while drilling anchor bolts for his column forms. I've also noticed that the cables require additional clearance around such items as columns and other cables. Nevertheless, such work requires a greater detail of attention to layout.

We've had one unusual turn of events on both jobs. It seems that the reinforcement subcontractor has been replaced on both jobs. We're not sure of the exact details nor is it really any of our concern as long as the work progresses. We did learn that the problem stemmed from the fact of poor cash flow. The reinforcement subcontractor was a sub of the concrete subcontractor on the parking garage and was not receiving a proper cash flow in order to pay his workers and materials. Apparently, he simply went under due to his poor management. We were concerned that this would slow down production; however, there has been no sign of slowdown to date.

APPENDIX VII. (CONTINUED)

This last month, I was able to spend several days following the planning stages of a project. I attended a Board of Regents meeting in order to understand their involvement in the planning stages. In a small sense, the Board of Regents action is similar to the action taken by the Congress of the United States on military projects. In fact, the Board of Regents require additional action once the project has been designed. The Boards action process can add a lot more time to the entire project schedule from conception to finish. Besides attending a Board of Regents meeting, I was a voting member on the architect selection committee for the new educational facility at Galveston. In November, I took part in the selection process of narrowing down the number of architects we would like to interview for the actual design. The interview list was narrowed down to six firms who were asked to provide a presentation on the project. On 11 and 12 December, 1989, a technical review committee was formed to evaluate the A/E submissions and presentations. Each A/E spent approximately two hours discussing their firm, consultants, schedule, previous similar work and approach to this design. The intent of the technical review committee was to provide a recommendation to the selection committee on each of six firms. I was serving as the construction division voting member on the selection committee (four members total.) The selection committee met on 13 December, 1989 to vote for the A/E. The final votes were sealed and General Peel will tally the results and present the results at the next Board of Regents meeting for their approval. In summary, I think the procedure is very fair and worthwhile. At this point, there are very few recommendations I could make on improving the system. One interesting point: I sat in on all six A/E presentations and saw six completely different approaches to their presentation methods. Some methods were extremely effective while some may have tarnished their selection chances.

There were several small computer problems that required my attention during the month of December. The construction division hired a new computer system manager last August. He is excellent when it comes to software packages like Supercalc and Fox Base; however, he is still learning about hardware. One of the biggest contributions I make to this organization is in teaching him several new software packages and hardware corrections. In the last three months, he has learned several valuable time-saving

APPENDIX VII. (CONTINUED)

tools with the aid of a computer. He's also fixed several hardware problems. We're to the point where he does all the work and I simply watch over his shoulder and provide advice. For example, he had to return a borrowed computer and swap out two office computers last week. Such a task was compounded by the fact that the none of the three computers were the same type nor had the same software installed. Although he had some minor problems, the process went rather smoothly.

Next month, I plan on beginning the actual research for cost projections.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

2 Mar 1990

Re: Doctor of Engineering Internship Progress Report
(1 Jan 90 - 28 Feb 90)

This letter summarizes progress for the period 1 January 1990 to 28 February 1990. This is the fifth progress report written.

I've combined the January and February progress reports since the month of February involved attendance at a construction seminar and the continuation of developing a computer based construction forecasting program.

I was able to complete my final objectives for the internship and they have been approved by all parties at Texas A&M. I've completed all requirements except the final report after the internship.

In January, I begun to research and develop the forecasting model. I was able to find 1200 payment records on 92 contracts that dated back to 1985. This information was needed to run the statistical analysis to develop a forecasting equation. I was able to use Quattro Pro and a public domain regression program and have come up with a linear equation, quadratic and cubic equation. I've gone back and used these equations to plot a forecast curve on top of the actual curve and found the equations to be fairly accurate. The problem I noticed is due to the "S shape" of the original curves. There is simply too much error in using a linear equation against the "S shape" curve near the tail regions. The quadratic and cubic equation compensated for the tail end but did not do as well in the middle months of the project. I addressed this problem with Dr. Kannan and his solution will work fine. He suggested using three linear equations, one on the bottom tail, the middle region, and the ending region.

APPENDIX VII. (CONTINUED)

I have not completed the work on analyzing the data for three equations. Since Earl Fratus is using SAS to do some of the same analysis, I've decided to wait and see his results before continuing any equation derivation. Since I had developed some equations, I decided to begin writing the database program that would incorporate the forecasting data and print out a three year forecasting report. I spent several days refreshing my program skills by going through some tutorial packages on database programming. I begun analyzing the database programs used in the office and realized that the forecasting report could be done with no additional user input. All the data and fields I needed were already in various database files. My main objective was to have a user generate the report without additional data input every month. In other words, I wanted to use existing information that was already in the computer.

I was only able to spend a few days looking at the programs and database files before I left for Madison, Wisconsin to attend a seminar entitled, "Successful Construction Management Techniques & Procedures." The course was excellent though it was one-sided toward the use of using a Construction Management (CM) approach with multiple bid packaging on construction jobs. The seminar was definitely applicable in my future internship objective in researching and recommending the use of a CM at Texas A&M University.

On my return to Texas, I begun to write the computer program for the forecasting report. Since I had to write the code along with other daily activities like job site visits, it was two weeks before I had completed the programming. The prototype looks good. Mr. Chapman has decided to use my report and their existing method for several months to compare the two methods. The new report takes less than 10 minutes compared to several hours. If the report is acceptable, the only remaining work will be to establish the three equations mentioned earlier.

The two construction jobs I'm associated with are progressing well even though there have been several construction claims and weather delays.

During the month of March, I plan to make any changes to the forecasting report and begin writing up the internship report on this objective. I currently plan to see if I can get this work published.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

2 Apr 1990

Re: Doctor of Engineering Internship Progress Report
(1 Mar 90 - 31 Mar 90)

This letter summarizes progress for the period 1 March 1990 to 31 March 1990. This is the sixth progress report.

After further review of the cost forecasting model, we noticed that the forecast was front heavy. In other words, the initial months of the larger projects had a large forecasted cost. Rather than wait for future analysis I began to reanalyze the data and develop a more accurate forecasting model by looking at ranges of the total construction amount. I noticed that the smaller jobs had a higher percentage of cost at the beginning of the projects which tended to obscure the general curve. I rearranged the data into three areas: job less than $3 million, between $3 & $7 Million, and greater than $7 Million. After running new curves, I noticed that the curves were similar in shape but were different for the ranges mentioned above. After installing the new equations in the program the cost forecasting report was more reasonable. I ran several plots of the curves against previous data and the plots were extremely close to the actual data. In fact, the correlation coefficient was 96%. I'm still using a fourth order equation. The linear and quadratic equations simply have too much error and do not match the data as close as the fourth order equation.

The two construction jobs I'm associated with have finished most of their structural work and are progressing well. I will be assuming total project manager duties for both jobs and the MC project the entire month of May. The current project manager will be on vacation. The $29 Million MC project began last month and is already progressing rapidly. During the month of April, I plan to work on the office job accounting system.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

2 May 1990

Re: Doctor of Engineering Internship Progress Report
(1 Apr 90 - 30 Apr 90)

This letter summarizes progress for the period 1 April 1990 to 30 April 1990.

I had planned to work on the office job accounting system; however, I spent the time on four construction projects. Since August, I've been working with George Cole, the full time project manager (PM) on the Wave Tank and Parking Garage projects. George also manages the Bizzell Street and the MSC Expansion Projects. George will be on vacation for three weeks in May so I've assumed the full responsibility for the PM tasks on all four projects. Therefore, I spent the month of April working with George in order to handle his duties in his absence. There have been several major problems on all four projects which required various meetings and contract revisions. Besides construction issues, we had to deal with several user requested changes. I expect the next several weeks to be very busy since there still are some major issues we haven't solved as of 2 May 1990.

In just the last month, I've taken part in just about all phases of construction from site layout to finish work and acceptance. I thoroughly enjoyed my internship last month and am looking forward to the rest of May.

I did spend a few days in April working on contractor schedules and helping the Administration division with some minor computer problems.

In summary, the entire internship has already exceeded my expectations. Not only have I benefited from this internship, but I feel I'm making valuable contributions to the organization.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

4 June 1990

Re: Doctor of Engineering Internship Progress Report
(1 May 90 - 31 May 90)

This letter summarizes progress for the period 1 May 1990 to 31 May 1990. This is the eighth progress report.

The month of April was extremely busy with the construction projects. The full time project manager (PM), George Cole, for the Wave Tank, Parking Garage, Bizzell Street and the MSC Expansion Projects was on vacation for three weeks. During Mr. Cole's absence I was able to assume full responsibility for the PM tasks on all four projects. During the month of month of May, I was involved with just about any aspect of construction imaginable. I conducted three monthly meetings, coordinated and issued several large change orders, handled a one year inspection on a completed dormitory project, had faulty work redone, inspected steel layout for compliance, coordinated with several users on new work, settled a few claims, assisted in solving utility line breaks, etc.

May was an excellent month to witness the effects of a tight contractor schedule to slip because of unforeseen consequences. The Wave Tank schedule began to slip because of the steel fabricator subcontractor going under and the crane supplier failing to coordinate proper dimensions. Both instances caused several weeks delay which effected the entire schedule. Since the middle of May, we have asked for a new schedule in order and expect it at the next monthly meeting on 6 June 1990. The Parking Garage critical path has changed since the site work subcontractor has not began making that activity now on the critical path.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart
Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

31 July 1990

Re: Doctor of Engineering Internship Progress Report
(1 Jun 90 - 31 July 90)

This letter summarizes progress for the period 1 June 1990 to 31 July 1990.

The month of June was busy with the construction projects. Both projects, the Parking Garage and Wave Tank, have completed the majority of the outside work and have started working inside with all the electrical and mechanical work. The Parking garage does not have as much electrical or mechanical inside work but there were several minor problems that had to be resolved before work could resume. The Wave tank had additional problems but were easier to resolve. Both projects required several revisions in order to add new user requirements. The new requirements were minor in detail but required cost estimates and price negotiations. Besides the two projects mentioned above, I worked a little with the MSC projects while the inspectors were on vacation. The only significant problem was a collapsed wall which the contractor accepted as his problem and replaced it at his expense (he backfilled against the wall without enough supports and may have hit the wall with some equipment.) While I was gone the last two weeks of July, another wall cracked due to poor supporting.

During June, we began computer input on the office job accounting system. I finished the computer programming to monitor and input time sheets on all the employees in the office. To date, we have over a month of data. In August, I will incorporate salary information into the program in order to provide financial reports. These reports will break down the amount (in dollar terms) that the office personnel spend on various job tasks and activities.

APPENDIX VII. (CONTINUED)

THE TEXAS A&M UNIVERSITY SYSTEM

FACILITIES PLANNING AND CONSTRUCTION

Dr. George Stukhart 10 Sep 1990

Construction and Materials Group
Civil Engineering Department
Texas A&M University
College Station, Texas 77843

Re: Doctor of Engineering Internship Progress Report
(1 Aug 90 - 31 Aug 90)

This letter summarizes progress for the period 1 June 1990 to 31 July 1990. This is the tenth progress report written.

August was the busiest month of the internship. The Parking Garage was completed on time the 15th of August. Pre-final inspections were done before the 15th and minor corrections were accomplished before the University took beneficial occupancy of the garage. Minor corrections to the electrical security system were delayed until after the 15th and accepted at a later date. The garage was opened as planned for the upcoming fall term. The contractor's superintendent would remain on site through September accomplish last minute punch list items and any items identified during the first month of operation. There are several claims pending negotiations otherwise the project is totally complete except for the one year inspection and any further warranty items.

The Wave Tank contractor is planning to finish on time in September. There are several engineering design deficiencies which may delay the completion date if not resolved in the near future. For example, the personal carriage rail cannot be aligned unless a major change order is issued and the proper correction is research and designed. The rail could not be aligned due to an earlier change order that effected the width of the pool wall where the rail rest on. The change was compounded by the fact that the original rail system does not have enough adjustment factor to accommodate the 1 inch error in the width of the wall. Nevertheless, several engineers, inspectors and contractor personnel will look at various corrections the first week of September. The wave absorber was an alternative at bid opening that was not

APPENDIX VII. (CONTINUED)

accepted by the University. However, the user has come up with additional money and the design and would like the absorber installed under the current contract. We approached the contractor and asked for his price quote before issuing a change order but there is no doubt that the contractor does not want the job since his price quote was three times our estimate. So, we assisted the user in issuing a purchase order to a local manufacture to build and erect the absorber as soon as possible. At this time, we do not believe that the absorber contractor will finish his work before the prime contractor which complicates final acceptance of the project. In addition to the above mentioned problems, the wave machine contractor Davis Engineering from Canada) is behind schedule due to the delay in the operation of the overhead crane. All these delays effect the completion date since the tank cannot be filled to test all the equipment until all the contractors finish their respective contracts. The project cannot be extended past the end of October since the user has scheduled its opening with several predominant visiting dignitaries schedule to attend. If the facilities is not operational by the middle of October, the opening will have to be rescheduled until next year due to the schedules of the visiting dignitaries.

Between the finishing inspections on the Parking Garage and the problems with the Wave Tank, I was able to complete the office accounting system with the salary information. Besides tracking time the computer program calculates hourly rates for each employee and assigns appropriate costs to the various activities and tasks. After a three week trial period, I installed the programs on the network and trained the secretaries on the use of the programs and various reports. I also wrote a staff database program so Mr. Chapman can update his office staff and pay information.

The Forecasting program has been working fine and Mr. Chapman is extremely pleased with it. I did spend two days updating the program. I wrote the program code and database files to work for fiscal years 90, 91 and 92. However, it would require minor changes each year to drop a year like 90 and add a year like 93. Since I wrote the program code I changed the files to work on any three years where the user identifies the first fiscal year. This change negates the yearly program code changes. After a half a year of use, Mr. Chapman believes we are well within 10% of forecasting actual construction costs

APPENDIX VII. (CONTINUED)

two years into the future and it can be done in less than ten minutes on over 40 projects.

Unfortunately, the month ended on an extremely unpleasant note with the medical results for Debbie, my wife. The diagnoses of cancer was by far the worst news I have ever heard. Our fiends and church family have been extremely supportive which has helped immensely. At this time, I still expect to finish this fall semester and will keep you well informed of any changes to my plan.

VITA

NAME/GRADE: Michael Floyd Reynolds, Major, USAF
PERMANENT ADDRESS: [redacted]

BIRTH [redacted]

ACADEMIC EDUCATION: BSCE, United States Air Force Academy, 1977
MSIE, Purdue University, 1980

ASSIGNMENTS: Dec 86 - May 88: Chief Operations and Maint., 3 SSW/XRE, Peterson AFB, Co. Inspects, evaluates, tests, assists and supports thirty-six radar sites worldwide.

Nov 83 - Dec 86: Assistant Professor, Department of Civil Engineering, USAF Academy, Colorado. Instructed Air Force Academy Cadets in several civil engineering courses and Director of Research.

Oct 82 - Nov 83: Construction Engineering Manager. Riyadh, Saudi Arabia. Provided Air Force liaison, interface and construction management in the technical engineering section on a $2.0 billion Foreign Military Sales supporting the Royal Saudi Air Force (RSAF),Riyadh, Saudi Arabia.

Jan 82 - Oct 82: Chief Resources and Requirements, Minot AFB, ND. Supervised the daily operation of planning, ordering material and scheduling work orders and job orders for in house personnel.

Jan 81 - Jan 82: Chief Construction Management, Minot AFB, ND. During this period 14 million dollars of construction was underway. Established an effective construction inspection training manual.

Jun 77 - Aug 79: Assist. Chief of Operations, Peterson AFB, CO. Assisted the Chief of Operation who supervised 240 individuals. Assisted in the daily operations to maintain and repair base facilities with in-house personnel.